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Technology-Based SMEs and the Geography of Knowledge Sourcing:  
A Systematic Review of Empirical Evidence

School of Management  
MRes Dissertation

MRes in Management Research  
Academic Year: 2010 - 2011

Supervisor: Prof. Mark Jenkins  
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degree of Master of Research

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## **ABSTRACT**

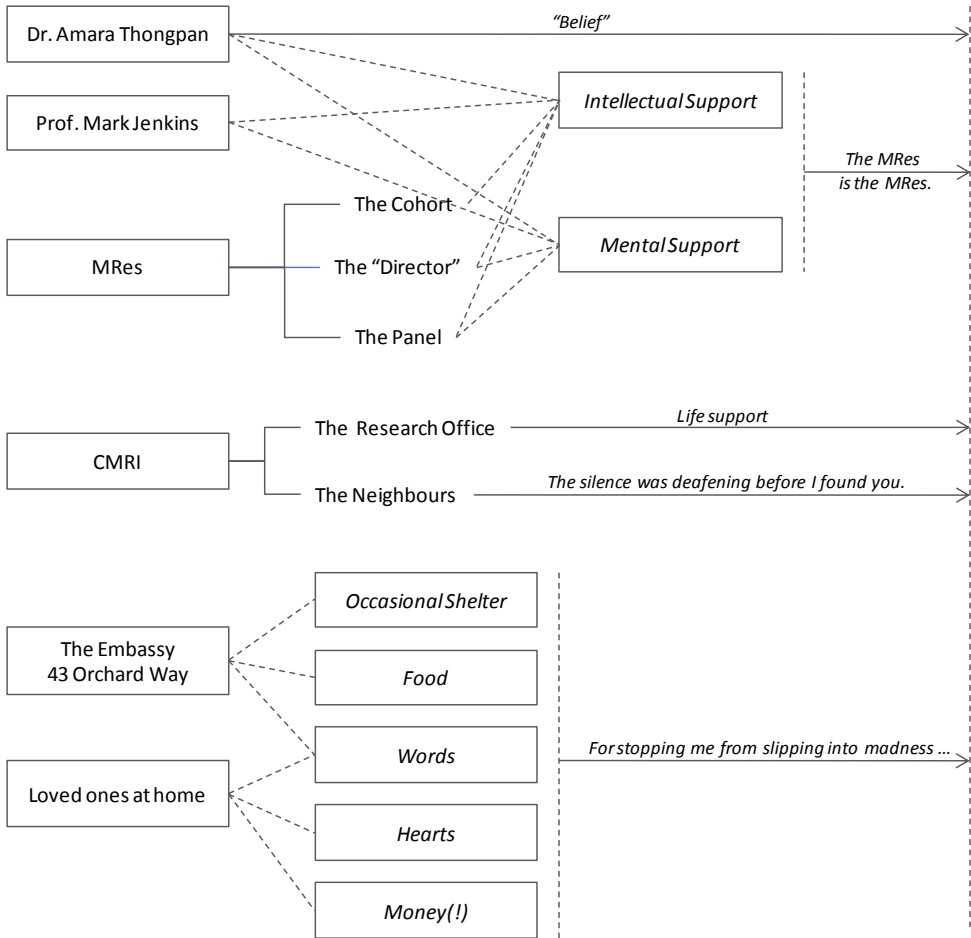
Knowledge access is crucial for firms, especially those with resource constraints facing the rapid change in technology. This systematic review attempts to provide an understanding on how technology-based small and medium-sized enterprises (SMEs) source external knowledge. With the extant literature pointing to the spatial characteristics as the central theme, I identify four generic conditional dimensions that shape the overall geographical pattern of knowledge sourcing. The industrial knowledge base, the market, the local conditions, and the institutional environment influence from whom and where firms source knowledge. The empirical evidence leads to my contention that the conditional dimensions presented are far from being straightforward. Points of caution that should be incorporated when interpreting general patterns are discussed. The main argument is that further understanding of the geography of knowledge sourcing may start from generic external factors but contextual sensitivity and analytical interpretations are invariably essential. Further research opportunities call for more understanding on a) the relationship between private firms and the institutional environment, b) how an individual firm builds and develops own network, and c) how relational asset and different types of knowledge interact.

Keywords:

Networks, Clusters, Spatial proximity, Innovation, Knowledge access, Systematic review



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"Thank you."

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# **1 INTRODUCTION**

## **1.1 Overview**

A certain part of technological advancement goes hand in hand with business creation, as the relevance in application and the technical development forms a virtuous cycle. As we know it, much of the business part is taken care of by entrepreneurship. Basing on their technical expertise, entrepreneurs build their business offerings, whose success or lack thereof guides further choice of technical progress. However, neither business nor technology can be considered a solitary enterprise. Characteristically speaking, those undertaking new technological challenges are likely to be small in size and thus commercially vulnerable. Also, more often than not, a single area of technical expertise does not suffice for a viable product/service offering. The notion of SMEs not usually possessing all the necessary resources forms the basis of this systematic review.

Further to such discussion, is there any particular kind of resources that deserves more immediate attention? In this review, the highlight will be placed on knowledge as the most strategically important resource for a firm's competitiveness. On a broad level, we look into the concept of interorganisational networking as a means for independent, smaller firms to acquire knowledge. Conceptually, the association between networks and knowledge acquisition/creation of participating organisations is well-established. In fact, knowledge sharing, creation, and acquisition, have contributed to the most significant argument for networks, spatially bound and otherwise. This leads to the concept's prominence in the field of public policy, especially in the realm of technological entrepreneurship development in which the implementation has been met with mixed success. While the reasons for which remain largely debatable, this systematic review takes a step back to visualising the interorganisational processes as they unfold in context.

## **1.2 The purpose of the review**

In this review, I wish to see to what extent the literature can generate a better understanding of how technology-based SMEs source knowledge from their networks. The question is asked from a firm's perspective so as to complement the network view that have been more readily available in the literature. Since it is expected that the relevant literature can be less than abundant, I hope to uncover some under-researched aspects of the phenomenon that may form a basis for subsequent research.

## **1.3 The structure of the document**

The document is structured as follows:

Chapter 2: The chapter introduces relevant concepts that are necessary for the overall understanding of the phenomenon of interest.

Chapter 3: The chapter outlines how the systematic review process was carried out, along with its underlying logic.

Chapter 4: The chapter provides a descriptive overview of the selected texts and indicates what implications they have for the review.

Chapter 5: The chapter presents the findings garnered from empirical research.

Chapter 6: The chapter discusses the findings, exposes the limitations and proposes how the two may be able to generate understanding of the phenomenon. It also offers policy implications as well as further research opportunities.

Chapter 7: The chapter concludes the review.

## 2 POSITIONING THE FIELD OF INQUIRY

There are three domains shaping the choice of the review question as follows:

**Table 2-1 Literature domains**

Domain	Relevance
<b>1. Technology-based small and medium-sized enterprises (SMEs)</b>	The context: Small and medium-sized firms, while regarded as instrumental in innovation and regional development, normally operate under resource poverty, entailing significant challenges in public policy and business.
<b>2. Clusters</b>	The interorganisational arrangement: As a frequent response to SME challenges, the concept addresses how co-location helps firms overcome resource constraints, bring collective gains and lead to competitive advantages.
<b>3. Resource-based view of the firm</b>	The theoretical perspective: The theory addresses how competitive advantage is defined and how/why it can be created by firm-specific resources.
<b>3.1 Knowledge-based view</b>	How knowledge as a strategic resource created in clusters contribute to competitive advantages in both cluster and firm levels.

In this chapter, I introduce technology-based small and medium-sized enterprises and their policy relevance as they form a contextual basis. I then turn to clusters as one of the frequent policy responses, along with the resource-based view of the firm as the logic behind the perceived benefits of clusters. Knowledge is then identified as the most important resource on which the systematic review focuses. Building on a relatively simple conceptual discussion, I then extend it to the challenges posed in practical settings of cluster policy and research. The challenges combined with a more relaxed view of spatial proximity informed by contemporary research then lead to the review question that forms the basis of this systematic review.

### **2.1 The context: Technology-based small and medium-sized enterprises (SMEs)**

The most significant notion attached to small and medium-sized enterprises and entrepreneurship is arguably job creation, with innovation trailing as the secondary

contribution to economic development (Dennis, 2011). Also commonly accepted is the resource poverty looming over SMEs' conception and day-to-day operation (Carland, Hoy, Boulton and Carland, 1984). This applies to a large degree to technology-based SMEs (henceforth SMEs, as SMEs in other industries are not discussed). While the small size brings the advantages of flexibility and agility, in the face of rapid technological change, the size also poses serious problems of insufficient resources and capabilities possessed by these SMEs (Narula, 2004).

The performance of SME policies tend to be evaluated in relation to employment growth (Audretsch, 2004). However, that the notion is well accepted in public policy (OECD, 1999) in itself may not warrant research attention. Debate remains as to whether the supposed contribution has been exaggerated, with sceptics (Davis, Haltiwanger and Schuh, 1996; Parker 2001) as well as proponents (Carree and Klomp, 1996; Davidsson, Lindmark and Olofsson; 1998). From my perspective, research on SMEs can be justified not by their policy performance but by a mere share of employment in any given economy (Carland *et al.*, 1984). As a policy challenge, the alleged failure of SMEs and entrepreneurship in living up to expectations ironically begs more understanding and further correction than otherwise would have been the case had they been conspicuously successful.

For the clarity of the systematic review, distinction has to be made between SMEs and entrepreneurship. The two terms are often present simultaneously in the same discussion, giving an impression that one is implicit in the other. While they do overlap, their definitions are based on different constructs. The main concern of SMEs is on the size of the firm in question, however measured, regardless of its age and business focus. Entrepreneurship in general means "the creation of economic activity that is new to the market" (Davidsson, 2006:3), thereby pertaining to what a firm does instead of its size or condition. Thus, not all SMEs are entrepreneurial and certainly not all entrepreneurial ventures have to be small. There is thus a striking difference between entrepreneurship policy and SME policy as the two direct at different, though often overlapping, concerns. Entrepreneurship policy targets "entrepreneurial vitality

in a region or a country” (Lundstrom and Stevenson, 2001: 19). It aims at entrepreneurial processes at a firm’s start up as well as the preceding and the following periods. SME policy, as suggested by the label, targets the promotion of firms of a certain size range (Lundstrom and Stevenson, 2002). Therefore, they operate at different units of analysis (Audretsch, 2004).

It is generally perceived that newness rather than smallness is more important in job creation (Davidsson *et al.*, 1998; OECD, 1999). However, the fact remains that entrepreneurship policy is embedded in SME policy instead of existing in its own right (Audretsch, 2004; OECD, 1999). This makes a crucial point informing the choice of context. It follows that SMEs as a class of firms, instead of entrepreneurship as an organisational orientation, are directly entitled to policy support. With the current frame of policy, I would base this systematic literature review on SMEs rather than entrepreneurship.

So far, the context has been framed mainly in view of policy relevance. The main interest of public policy, however, is not in the success of any particular firm but instead the aggregated success of a particular locale (Audretsch, 2004), demonstrated by SME statistics (OECD, 2010). It is in my interest to look more closely at the conduct of firms, the understanding of which is hoped to be able to inform business practice.

### **2.1.1 The contextual scope**

SMEs are defined differently across countries, and within a single country across different sectors (Harvie, 2004). Apart from the resource poverty they often share, SMEs are inherently heterogeneous such that generalised policy tends to be inappropriate. The particulars of what would be relevant to the scope of this study have to be identified.

- SMEs included in this review must offer technology-based products/services.
- University spin-offs are not within the scope of this review. University entrepreneurship mainly concerns direct commercialisation of academic

research. The resource base, the business focus, the institutional relationships, the legal requirements, or the “game rules” in general are much different from typical privately founded SMEs. In my opinion, the distinctiveness of the phenomenon warrants a separate review. See Rothaermel, Agung and Jiang (2007) for the overview of the body of literature in university entrepreneurship.

- SMEs supplying exclusively to multi-national enterprises (MNEs) are also not within the scope of this review. Unlike more independent SMEs, these outposts inevitably hinge on the preferences and the authoritative governing power of MNE clients (Chaminade and Vang, 2006; Dyer and Nobeoka, 2000). While MNE-SME relationships give rise to crucial policy and managerial challenges, they will likely lead to a very different terrain of research.
- Likewise, subsidiaries of MNEs are not included. The nature of endowment and the influence of the parent firm mean that the capabilities and business requirements are conceived of differently from those of independent SMEs. Thus, subsidiaries are found to have different pattern of interactions with local entities (Beers, Berghäll and Poot, 2008; Sadowski and Sadowski-Rasters, 2006).
- Only existing SMEs will be included though there is no restriction regarding the age of a given firm. My decision on this criterion is shaped by a policy aspect of job creation. While new firms contribute more significantly in job creation (Davidsson *et al.*, 1998; OECD, 1999), their lack of longevity poses a serious threat to net job creation and employment growth (OECD, 2010; van Praag, 2007). The understanding of what more mature (i.e. surviving) SMEs do should also factor into the investigation.

Policy responses to SME challenges frequently involve networking of firms and institutional organisations (Carlsson and Mudambi, 2003), which often entails geographical properties (Dennis, 2011). The following section frames the general idea of what clusters are and how they function in a conceptual manner before we turn to the underlying theoretical logic of how clusters may benefit member firms.



## **2.2 The arrangement: Clusters**

### **2.2.1 How firms relate in clusters**

Porter (2000: 254) defines a cluster as “a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities”. Clusters also involve related entities important to competition, such as suppliers, firms in related or downstream industries, and associated institutions (e.g. universities, standard agencies and trade associations) in a specific field.

Although collaboration is a theme that often takes centre stage in cluster research, it is widely acknowledged that relationships within a cluster can range from intense rivalry to collaborative relationships (Gordon and McCann, 2000; Maskell, 2001). The nature of a given inter-firm relationship depends largely on the firms’ competitive position. Intense rivalry commonly occurs among similar firms (i.e. horizontally) whereas collaboration tends to take place along the supply chain (i.e. vertically).

By being located in the same neighbourhood, similar firms may be able to benefit from external economies “as if it had greater scale or as if it had joined with others without sacrificing its flexibility” (Porter, 1998: 81), which is an argument closely linked to Marshall’s (1920) externalities of industrial districts. Vertically linked (though not integrated) firms benefit from their complementarities. Horizontal ties enable collective resource use and innovative capacity, whereas vertical ties are linked to increased manufacturing capacity (Mesquita and Lazzarini, 2008).

In simple terms, clusters can be thought of as assuming two generic types of identity, technology-based or sector-based (St. John and Pouder, 2006). Clusters can also be categorised in other ways, such as by the nature of firms’ interactions and the resulting advantages (Gordon and McCann, 2000) or the level of coordination and control that governs their structure (Arikan and Schilling, 2011). Clusters of different structures have different ways to form, require different forces to sustain, accruing different

benefits to member firms, and generate different logics of competitive advantage (Arikan and Schilling, 2011). A typology is normally based on ideal types, which means that more often than not, a given cluster does not fit perfectly into any single category (Martin and Sunley, 2003).

### **2.2.2 The inadequacy of cost-based explanations for the existence of clusters**

Transaction cost advantage can only partially explain the advantages associated with the co-location of *independent* firms. After all, vertical integration of different functions into a large firm is theoretically more cost-effective and operationally efficient. An interesting question, as posed by Maskell (2001: 927), reads as follows:

What are then the advantages of  $N$  co-localized firms of size  $S$  undertaking related activities that are not transferable to a single firm of size  $S \times N$  doing the same?

The answer lies in the inter-firm relationships (albeit rival ones) along the horizontal dimension of a cluster. The horizontal competition represents a collection of experiments unattainable by a single firm, as knowledge of what went wrong or failed experiments can also be useful but not formally reported (Bathelt, Malmberg and Maskell, 2004). As performances of clustered firms are easily observed and compared, combining with the shared contextual understanding, the consequences of any clustered firm's decision become transparent. In a single firm of any size, exploring such diverse directions regarding the same product is highly problematic, if not impossible. It should be noted that trust is not a requirement for this type of learning. The only prerequisite, at least in principle, is that many firms undertaking similar activities co-localise in a manner that allow them to monitor their competitors closely without incurring high costs (Maskell, 2001).

### **2.3 The theoretical perspective: The resource-based view of the firm**

The resource-based view of the firm (henceforth, RBV) underpins how firms can gain sustained competitive advantage, based on the opportunities arising from own resources. RBV was formally introduced by Wernerfelt (1984) as a means to analyse a

firm from its resource profile and the strategic options that stem from it. Barney (1986) discusses how two different sources of insights contribute to the value of a firm's strategy—the analysis of the firm's competitive environment, and the analysis of the firm's existing skills and capabilities. The basis for the former (information collection methods and conceptual model) would largely be in the public domain (Porter, 1980) and does not serve to systematically differentiate individual firms in a competition. Operating on the assumption that firm heterogeneity is the prerequisite for the existence of competitive advantage, Barney continues with the importance of an introverted stance by proposing a model of resources-competitive advantage (Barney, 1991). Firm resources are “strengths that firms can use to conceive of and implement their strategies” and such strengths may lie in various types of organisational assets, knowledge, capabilities, or processes. A competitive advantage enables a firm to implement “a value creating strategy not simultaneously being implemented by any current or potential competitors” (Barney, 1991: 101).

### **2.3.1 The cornerstones of competitive advantages**

Not all resources have equal potential to generate competitive advantages. I would like to bring into the discussion the criteria from Peteraf (1993), which consist of heterogeneity, *ex post* limits to competition, imperfect resource mobility and *ex ante* limits to competition. Particular attention will be given to *ex post* limits to competition, as they form the basis for much discussion of why a cluster may generate a competitive advantage both as a group and for an individual firm.

Heterogeneity: This is the most basic condition for the existence of competitive advantage. Barney (1991) makes a similar observation by stating that if all firms' resource collections were alike, all firms would implement the same strategies and obtain the same results, hence no competitive advantage exists in such a world.

*Ex post* limits to competition and resource immobility: This notion concerns the durability of the heterogeneity. If the heterogeneity is short-lived, so too will be the competitive advantage. For the issue of imperfect imitability, much of the logic rests

on causal ambiguity (Lippman and Rumelt, 1982), path dependency (Nelson and Winter, 1982) and untradeable asset stock accumulation (Dierickx and Cool, 1989), all of which limit other firms' ability to buy success (Grant, 1991), rendering such resources imperfectly mobile.

Ex ante limits to competition: *Ex ante* cost of acquiring resources, tradable or non-tradable, must not exceed the *ex post* profit (Barney, 1986).

### **2.3.2 The outgrowth of RBV: The knowledge-based view of clusters**

Knowledge is currently regarded as the most strategically important resource (Grant, 1996). Knowledge-based view of cluster (Maskell, 2001) highlights the ability of clusters to help firms generate competitive advantages, most prominently through innovation by combining old and new, internal and external knowledge (Kogut and Zander, 1992).

In relation to Peteraf's concept, if a cluster could generate a competitive advantage, such advantage would likely be tacit, socially complex and location-specific such that it is unique only to clustered firms. Most of the reasons cited for the success of knowledge-based clusters e.g. that explained by Saxenian (1994) are not strictly economic. Instead of transaction cost or the ease of access to physical resources, competitive advantages of clusters tend to be associated with locally bound interactions of cluster members (Malmberg and Power, 2005). Borrowing from the concept of communities of practice (Brown and Duguid, 1991, 2001), a cluster is thought to serve as a common platform upon which socially constructed meanings are agreed upon. Such mechanism tends to be much less transparent to outsiders, hence the location-specific characteristics of a cluster. The knowledge-based view of clusters rests on this theme. A cluster creates a competitive advantage both at the cluster and firm level by serving as a venue for knowledge interchange between firms (Arikan, 2009).

Building on the concept of untraded interdependencies, knowledge exchange within a cluster takes a unique form, giving rise to a unique stock of architectural knowledge

(Henderson and Clark, 1990; Matusik and Hill, 1998) in both cluster and firm level. This type of knowledge, as opposed to component knowledge, is ingrained in an organisation's routine. The stock of architectural knowledge, being difficult to imitate and mobilise, forms a basis of competitive advantage (Tallman, Jenkins, Henry and Pinch, 2004).

## **2.4 Clusters and the operationalisation struggle**

The theoretical discussion so far reveals the potential benefits from clusters, at least in theory. Clusters are thus thought to be particularly relevant to SMEs (Bocquet and Mothe, 2010; Delgado, Porter and Stern, 2010) or new ventures confronted by uncertainty (Gilbert, McDougall and Audretsch, 2008). The concept has gained widespread acceptance in regional innovation policy (Morgan, 2004). However, there is no guarantee for the theoretical appeal to translate perfectly in practice, as demonstrated by the marked variation of cluster success (Hanna and Walsh, 2002). It is commonly accepted that gaining control over the formation and the direction of clusters is notoriously difficult (Carlsson and Mudambi, 2003; Smilor and Feeser, 1991).

Putting aside the politics of cluster promotion (Martin and Sunley, 2003), we turn our attention to how a simple concept may unfold into real-world challenges. As put by Morgan (2004: 17), "The growing interest in clusters, among theorists and policy-makers alike, is paralleled by an increasingly ambiguous evidence base". I would like to highlight the vagueness of clusters as a very important issue that initiates confusion and impedes understanding in contemporary research and policy-making.

The vagueness discussed here mainly concerns the definitional issues surrounding the concept. One of the most significant is the question of what constitutes a cluster, i.e. the spatial scope. There is no fixed physical definition for the boundary issue (Porter, 1998) perhaps for good reason. Interdependence is generally deemed more suitable in visualising the boundary of a cluster (Maskell, 2001). While interdependence may be strengthened by co-location, there is no spatial character inherent in such a notion. The situation becomes more challenging when taking into account how clusters can

cohere into multiple types of structure and by more than one type of force (e.g. Gordon and McCann, 2000). How strong do interdependences, however defined, have to be for the firms to be “in” the cluster?

The elusive nature of clusters means that the existence of a given cluster can be very difficult to justify, with the exception of few success cases. In public policy, this has led to arbitrary efforts in cluster building, with the belief that clusters can be forged anywhere (Martin and Sunley, 2003). More relevant to our concern is how the situation leads to the way we see clusters. There are perhaps two scenarios—an emergent cluster is often a successful one, and an artificially created one is not. In the former case, linkages of firms in a locale can only become evident once a certain level threshold is reached. This invites a tautology. After all, did the cluster become successful because the firms are well linked, or are the firms well linked because they are in a successful cluster? If the interdependences are not strong enough to be visible, a cluster cannot be thought to have existed. The latter case pertains to a complication of imposing a supposedly meaningful spatial scope on a group of co-locating firms as well as the policy challenge in cluster building.

Despite concerns stated above, I am not denouncing clusters. An obvious reason for the choice of clusters as a point of departure is the policy relevance. Another reason rests on the value of geographical considerations for independent SMEs operating in a physical world for which clusters (or rather, Marshallian districts) as a simple form of territory provide the basic understanding of spatial advantages. Next, I extend to a more relaxed view of spatial scope which subsequently leads to the review question.

## **2.5 Clusters, permeability and alternative proximities**

It is well accepted that competitive advantages may arise not only from resources within a firm but also from relationship between firms (Dyer and Singh, 1998). One such way is demonstrated via the stock of architectural knowledge (section 2.3.2), but is such a notion confined within a cluster? As it turns out, the access to external knowledge is an essential factor to the survival of a cluster (Antonelli, 2000). Among

the most important concerns is the lock-in problem (Grabher, 1993) which results from excessive inward orientation and the oblivion towards external opportunities such that a firm's contextual embeddedness may turn into a liability (Uzzi, 1997), leading to stagnation and decline (Pouder and St. John, 1996). It is advised for clustered firms to optimise their intake of knowledge and information by utilising formal and informal, as well as proximate and distant types of relationship (Zaheer and George, 2004).

Bathelt *et al.* (2004) point out that local buzz in clusters can be rejuvenated by global pipelines of distant knowledge access formed by member firms. The types of interorganisational proximity needed for pipelines resemble those identified by Boschma (2005) which are cognitive, organisational, social, institutional and geographical. Indeed, geographical proximity strengthens other types of proximity although it is neither necessary nor sufficient in itself. The ties strengthened by spatial proximity can be redundant, as everyone shares the awareness of the same operating context. Ties formed with distant actors may be weaker and less instrumental in day-to-day operations but they can serve as bridges to otherwise disconnected actors (Granovetter, 1983, 2005). The notion of weak and strong ties frequently features in the discussion of interorganisational networks. While weak ties may be associated with innovativeness as a result of the opportunities they provide, different combination of both weak and strong ties would be a more likely case when taking into account the complexity of the knowledge being transferred and the utilities intended (Elfring and Hulsink, 2003; Hansen, 1999; March, 1991). However, despite the knowledge networks having become more globalised, Zaheer and Manrakhan (2001) do not expect the trend to undermine the importance of existing clusters as they often provide the loci in which knowledge is first created.

Networks are expected in the face of disconnected, multiple sources of knowledge required for a fast-changing field of technology (Powell, Koput, Smith-Doerr, 1996). The access to knowledge from sources of multiple geographical locations will likely allude to multiple dimensions of network relationships held by a given firm. While different types of network entail different dynamics of knowledge transfer, most

studies or theoretical models have been focusing only on a single network type (Inkpen and Tsang, 2005).

## **2.6 The review question**

The scope of the preceding discussion has been framed, in the first instance, by policy relevance from which I have identified SMEs and clusters as the firm type and the policy concept of interest. However, the way in which these two notions are handled in public policy has left some important questions unanswered perhaps because such issues are not of immediate relevance to the field. The main interest of SME policy is more in regional or national economic development rather than the competence or competitiveness of any single firm. This thus cascades down to managerial implications—what would, or should, SMEs actually do?

Since the question is to be in the interest of a firm, the main construct to be incorporated is knowledge. RBV's point of view generally holds that knowledge is the most strategically important resource (section 2.3.2). In particular for technology-based SMEs, inter-firm linkages are useful in helping them cope with technological changes as networking allows flexibility in acquiring new knowledge (McEvily and Zaheer, 1999). The phenomenon of interest is therefore the knowledge sourcing activities of technology-based SMEs.

While the phenomenon has built on the notions of clusters and RBV, the limitations and alternatives discussed in the previous two sections (2.4 and 2.5) suggest that the spatial scope should be more open. The review question then reads:

*How do technology-based SMEs source external knowledge from their networks?*

The choices of a firm-level question, the lack of definitions on spatial scope, and the absence of theoretical underpinnings in the questions are related. Generally, macro-level interests manifest in macro-level theories concerning the structural properties of networks. Using the literature to extract firm-level decisions in their external



knowledge sourcing may reveal some insights into why firms do what they do. It follows that such a question cannot be properly answered with a static spatial scope, as firms may not see their environment in the form of top-down, spatially-defined view employed by researchers or policy makers. Lastly, I do not expect theories to play a dominant role in the kind of empirical accounts I am seeking. In fact, the aggregate account of phenomena described in an atheoretical way may actually reveal further understanding of what matters from a firm's point of view and which theoretical lens would be suitable for further study.



### 3 METHODOLOGY

The literature review is a tool to “manage the diversity of knowledge for a specific academic inquiry” (Tranfield, Denyer and Smart, 2003: 208). It also helps researcher visualise, understand, and assess the existing body of knowledge in a particular field, enabling the advancement of knowledge.

However, in management research, the outcome of the literature review can be problematic and lacking of critical assessment as well as subject to poor quality evaluation of literature input. Since the literature review normally takes a narrative approach where the researcher selects the data based on own preference. It results in both the loss of knowledge and the bias infused in the resulting output. The systematic review process, applied from its equivalent in medical sciences, seeks to mitigate the bias by explicating the underlying values and assumptions. As a result, the process can also serve to strengthen the credibility of evidence, enhancing its suitability to inform practice (Tranfield *et al.*, 2003).

Being systematic requires the replicability and transparency of the process. In this chapter, the logic underpinning the methodology as well as the particular techniques used in conducting literature search, selection and extraction will be discussed.

The systematic review process encompasses five major stages.

1. Planning the review
  - a. Forming a review panel (Section 3.1.1)
  - b. Mapping the field of study (Chapter 2)
  - c. Producing a review protocol (this chapter)
2. Identifying and evaluating studies
  - a. Conducting a systematic search (Section 3.2)
  - b. Evaluating studies (Section 3.3)
3. Extracting and synthesising data
  - a. Conducting data extraction (Section 3.4)
  - b. Conducting data synthesis (Chapter 5)

4. Reporting (Chapter 4-5)
  - a. Reporting the findings
5. Utilising the findings (Chapter 6)
  - a. Informing research
  - b. Informing practice

### 3.1 Planning the review

#### 3.1.1 Consultation group

Name	Title	Organisation	Role/Expertise
Dr. Jonathan Lupson	Lecturer, Project and Programme Management	School of Management, Cranfield University	Panel Chair and review expert
Prof. Mark Jenkins	Director of Research and Professor of Business Strategy	School of Management, Cranfield University	Supervisor and content expert
Prof. Patrick Reinmoeller	Professor of Strategic Management	School of Management, Cranfield University	Scoping study panel member providing valuable advices in the positioning of the study
Ms. Heather Woodfield	Information Specialist for Social Sciences	King's Norton Library, Cranfield University	Expert in information and bibliography management
Mr. Alessandro Giudici	PhD Student (Strategic Management)	School of Management, Cranfield University	PhD student who has completed the systematic review process and shares similar interest within strategic management

#### 3.1.2 Mapping the field of study

See Chapter 2.

### 3.2 Identifying studies

#### 3.2.1 Search strategy

The aim of this systematic review is to gauge the current body of knowledge within management research, for which journal publication is the main vehicle of knowledge dissemination. Combining with the requirement for transparency and replicability, the primary source of literature would be the electronic databases.

Using electronic databases as the primary source of material did not automatically preclude other sources, such as books and reports. However, it should be noted that these other sources inevitably come to be known to a researcher in a much less systematic manner than do published, peer-reviewed papers. Also, the use of non-peer-reviewed pieces should be accompanied by heightened level of caution and care. Thus, non-peer-reviewed work could be used in exceptional circumstances for which journal articles were deemed inadequate. The use of other material sources will be discussed further below.

### **3.2.2 Electronic databases**

The electronic databases used for the search process were as follows.

1. ABI/INFORM Global™
2. EBSCO Business Source Complete

**ABI/INFORM Global** served as the primary search engine. It is regarded as one of the most comprehensive business databases, housing over 3,000 publications and more than 2,000 of which are available in full text. I had been using ABI/INFORM as the main database and found the coverage to be satisfactory.

*Applicable search field: "Citation and abstract" (restricted to scholarly journal only)*

**EBSCO Business Source Complete** has a reputation for its coverage of full-text articles and acted as the secondary source of material. My decision was based on my previous search experience, according to which I found search results from ABI/INFORM and EBSCO to be sharing much overlap, and ABI/INFORM to be able to locate the articles hosted on EBSCO perhaps as a result of SFX™ function. Most of the key publications for my research were accessible via both databases. I used this database to ensure thoroughness of the search results.

*Applicable search fields: "AB Abstract or Author-Supplied Abstract" (restricted to scholarly journal only)*

### 3.2.3 Keywords and search strings

From my knowledge of the literature in the field, at least in economic geography and strategic management, I noticed that the phenomenon of interest rarely made a focus of a journal article but instead tended to embed in one. It followed that the search string should be sufficiently broad and flexible. Thus, I kept the string simple, using terminologies common to the literature in the field rather than incorporating an exhaustive list of synonyms. The keywords for each component of the review question are listed below.

**Table 3-1 Keywords**

Component	Specification(s)	Keyword(s)	Explanations
Type of firm	Small and medium-sized firms, regardless of age and geographical location	SME, SMEs Start-up*, startup* Entrepreneur*, small firm*, NTBF*	While SMEs capture much of the relevant literature, startups and entrepreneurs that share SMEs' characteristics can be discussed without being directly referred to as SMEs. Similar firms are also found to be addressed as small firms and new technology based firms (NTBFs), especially in policy-oriented papers.
Key construct	Knowledge sourcing	N/A	The construct should emerge as a result of the review.
Type of resource	Knowledge	Knowledge	Knowledge is a commonly used term in the literature.
Operating context	Networks	Network* Cluster*	Network is an all-encompassing term, whereas clusters are essentially geographically bound networks. In a given piece of research, a network may have geographically based characteristics without being explicitly referred to as clusters. Geographical clusters are normally referred to directly as such. Both words are therefore necessary.

The resulting strings for “how do technology-based SMEs gain access to knowledge in networks”? and the number of entries obtained are as follows:

**“(sme OR smes OR start-up\* OR startup\* or entrepreneur\* OR small firms\* OR NTBF\*) AND (knowledge) AND (network\* OR cluster\*)”**

The search string results in 278 entries from ABI/INFORM and 350 from EBSCO, of which 124 were overlapping. The total number of papers for the relevance assessment was 504. More details on the assessment result are presented in section 3.3.3.

Returned search results seem rather large in quantity. However, I did not impose more constraints in the search string for two reasons. First, many of the irrelevant titles were easily distinguishable upon the preliminary scanning. Second, the empirical contexts of the research could be broad ranging, resulting in diverse terminologies being used. Not much could be done to anticipate more specific words that may be relevant to one context but not so in the other. The criteria for assessing the relevance of these papers are to be discussed in section 3.3.1.

It should also be noted that there were a number of potentially relevant keywords not being used in the final search string. Of particular concern were two issues—whether to incorporate information as the resource of interest, and whether to incorporate technology and innovation as an indication of the nature of business. Before the search string was finalised, the alternative keywords were tested and evaluated using the primary database ABI/INFORM. I decided not to include them in the search string for the reasons outlined in the Table 3-2.

**Table 3-2 Keywords not adopted in the final search string**

Experimented keywords	String	No. of entries (ABI/INFORM)	Reasons for not adopting keyword
Final search string	(sme OR smes OR start-up* OR startup* or entrepreneur* OR small firms* OR NTBF*) AND (knowledge) AND (network* OR cluster*)	278	N/A
"Information" in place of "Knowledge"	(sme OR smes OR start-up* OR startup* or entrepreneur* OR small firms* OR NTBF*) AND <b>(information)</b> AND (network* OR cluster*)	267	Interference from IT-based fields: Upon the scanning of 120 entries sorted by relevance, a large number of articles were from disciplines related to information technology or information systems and shared little overlap with the final search string (using "knowledge"). Overall, these articles were of limited relevance as the focus was more on enabling technologies instead of inter-firm networking or relationships.
Adding "AND (Technolog* or Innovat*)"	(sme OR smes OR start-up* OR startup* or entrepreneur* OR small firms* OR NTBF*) AND (information) AND (network* OR cluster*) <b>AND (technolog* OR innovat*)</b>	168	Constraints on search results: Upon preliminary scanning of the final search strings, some relevant or potentially articles did not contain "technology" or "innovation". Thus, content reading was adopted instead of using these keywords.

### 3.2.4 Other sources of information

Apart from peer-reviewed journals, there is a range of material from “grey” literature, such as practitioner journals, conference proceedings, books, policy papers and reports, which may lend themselves less to an objective and systematic process (Denyer and Tranfield, 2006: 222). They may be included based on the significance of their contributions in addition to the information readily gathered from peer-reviewed journals.



**Table 3-3 Other sources of information**

Material source	Decision to include	Explanations
Books	Included only if significantly contributing to the understanding of the phenomenon	Although books are often perceived to be of less academic rigour than peer-reviewed articles, books often provide insights into the phenomenon of interest in a detailed manner not usually attainable by journal papers.
Practitioner papers	Included if relevant	N/A
Working papers	Included only if providing novel insights not readily captured by peer-reviewed articles	Working papers, while usually lacking the same rigour possessed by peer-reviewed papers, may reveal emerging issues in a more timely fashion.
Conference papers	Same as working papers	Same as working papers
Policy papers/reports	Unlikely	Networks and clusters may invoke unquestioned acceptance in policy documents which may result in inherent biases.
Dissertations	Not included	Transparency of dissertations can be difficult to verify.
Internet documents	Not included	Credibility of internet sources can be difficult to verify.

### 3.3 Evaluation of material

#### 3.3.1 Selection criteria

Selection criteria formed a very important part of the review protocol, as the phenomenon of interest was not readily spelled out by means of search strings. On the contrary to traditionally drafted protocols, I chose not to impose separate selection criteria based on whether the titles, abstracts, or full-text papers were being examined. One set of generic criteria applicable to all three levels was used. The selection started from the titles onwards and reiterated in a more detailed level until a decisive action (include/exclude) could be justified.

**Table 3-4 Relevance criteria**

Criteria	Specifications	Explanations
<b>Empirical context:</b>		
- Type of research	Empirical	Understanding observed practice as captured in academic research was the main focus.
- Time frame	None	No preference given to any particular period by the review purpose
- Focal firms	Independent SMEs, regardless of age	<ul style="list-style-type: none"> <li>- Reflects my research interest</li> <li>- MNE-centric networks/clusters not included</li> <li>- Mergers and acquisitions not included</li> <li>- University spin-offs not included</li> </ul> (see section 2.1.1 for the explanations of contextual scope)
- Industrial sector(s)	Technology-based, though the technological discipline is unspecified	Reflects my research interest
- Type of network	None	Networks applicable for the review may or may not be geographically bound. Networks may be emergent, or initiated and organised by an institutional organisation.
- Geographical location	None	No preference given to any particular geographical location by the review purpose
<b>Content focus:</b>		
- Resource	Knowledge	<ul style="list-style-type: none"> <li>- Reflects my research interest</li> <li>- Integral part of competitive advantage generation as suggested by contemporary literature</li> </ul>
- Knowledge sourcing	As the most basic prerequisite, organisation(s) with whom the focal firms interact <i>must</i> be identified The nature of relationship between firms and organisations of interest <i>should</i> be identified The mechanisms used by the focal firms to gain access to knowledge <i>should</i> be explicated	I regard knowledge sources as the most basic component explaining how (from where) firms source knowledge. The nature of inter-firm relationships and the mechanisms used to gain access to knowledge are desirable but may not always be as readily obtainable.
- Research methodology	None	No preference given to any particular methodology
- Theoretical perspectives	None	Exposure to various perspectives was one of the main purposes of the review
<b>Material specifications:</b>		
- Journal disciplines	None	Exposure to various perspectives was one of the main purposes of the review
- Language	English	For pragmatic purpose

### 3.3.2 Quality appraisal

Papers with relevant content were also subject to quality assessment. The overall quality was assessed by a set of criteria which comprised the following components, each of which was subject to rating score ranging from 1 (low) to 3 (high).

1. Engagement with the existing body of knowledge
2. Methodology
3. Support of argument
4. Contribution

**Table 3-5 Quality assessment criteria**

Component	Scores		
	1 - Low	2 - Medium	3 - High
Engagement with the existing body of knowledge	Demonstrates low awareness of important literature, key ideas, and contemporary debates within the field	Demonstrates adequate awareness of important literature, key ideas, and contemporary debates within the field	Demonstrates thorough understanding of relevant background knowledge and contemporary debates
Methodology	Methodology and research question(s) mismatch	Methodology appropriate for the research question(s) though maybe with limited thoroughness in its inquiry	Methodology appropriate for the research question(s), enabling the inquiry to be conducted intensively
Support of argument	Findings and argument unrelated; or major logical/analytical flaw(s) observed	Adequate linkages between findings and argument and/or supporting theory.	Clear and logical progression from findings to argument; appropriate use of existing theories in support of argument
Contribution	No insights offered as an addition to the existing knowledge in the field	Incremental insights offered upon the existing knowledge/theories	Phenomenon of interest explained in a novel way; Uncover previously unknown phenomenon

Selected papers must score at least 2 in each criterion and preferably 3 in methodology and support of argument, since the focus of this review is on empirical research.

### **3.3.3 Final selection of core texts**

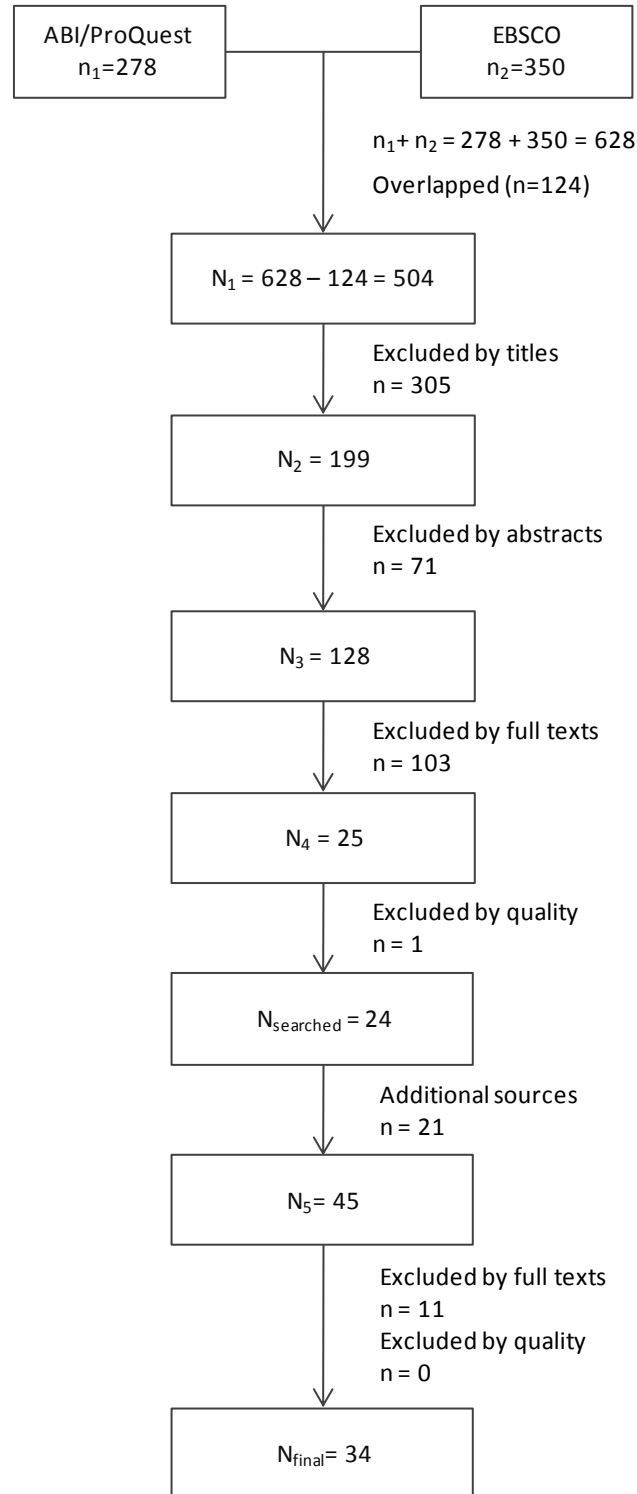
Search and evaluation processes above resulted in the final list of selected material. From 504 peer-reviewed journal articles, only 24 were deemed sufficiently relevant to the review question. As the result turned out to be quite small in number, I compared the number of final papers against a larger-scale systematic review on a related but much wider topic of “networking and innovation” (Pittaway, Robertson, Munir, Denyer and Neely, 2004). The authors located 127 journal articles through database search and abstract-level relevance selection. Therefore, the result of 24 papers from full-text selection did not seem grossly illogical.

Ten more journal articles were added to the final pool through cross-referencing, own collection and recommendations from the supervisor, bringing the total number of texts to 34. While a number of books and working papers addressed similar phenomenon, they did not provide empirically-based insights not readily captured by journal articles and were not included. More demographic and content-based characteristics on the final material will be discussed in Chapter 4. The summary of each core text is given in the Appendix.

The decisions to include or exclude texts obtained through database search were based mainly on each paper’s overall content and applicability to the review question rather than discrete components. While the process rested on the pre-defined selection criteria, some extension to cover specificities in the actual processes can be found below to provide more clarification for the subjectivity that was involved.

#### **3.3.3.1 Exclusion by selection phase**

The selections based on relevance criteria were carried out in three rounds on document titles, abstracts, and full texts. Relevant articles were then assessed for another round based on the quality criteria. The resulting number of texts excluded and retained is presented in Figure 3-1.



**Figure 3-1 Exclusion by selection phase**

### 3.3.3.2 Grounds for exclusion

Frequently used grounds for the exclusion of articles were:

- Indication of unrelated fields, especially for titles (e.g. Anand and Kodali, 2009)
- Indication of somewhat related fields but without sufficient potential to answer the review question (e.g. Davenport and Bibby, 1999)
- Based on the phenomenon of interest, that the article in question was:
  - Purely conceptual or not based on empirical data, although secondary or archival data were acceptable (e.g. Prashantham and Berry, 2004)
  - Addressing an intra-firm phenomenon, e.g. organisational learning, communities of practice (e.g. Branstad, 2010)
  - Not addressing technology-based firms (e.g. Pikkemaat, 2008)
  - Not addressing independent small and medium-sized enterprises (e.g. Cubillo-Pinilla, 2008)
  - Not providing indication of external knowledge sources (e.g. Pavlin, 2006)
  - Discussing network characteristics but based on other constructs, such as the agglomeration of financial capital, trust building, or social capital (e.g. Cooke, 2007)

These grounds were not mutually exclusive. Each rejected article was rendered so at the first applicability of any criterion.

### **3.3.3.3 Additional remarks on the included texts**

As many studies address multi-firm or multi-sector phenomena, an ideal compliance to the pre-defined criteria was not always the case. For example, Mytelka (2004) included some university spin-offs in the sample but made the final selection nonetheless. Saying that the study contained “sufficient” proportion of privately founded firms is admittedly subjective. However, I contend that an analytical judgment is necessary when examining an article whose immediate focus is not on knowledge sourcing even though it might go against the objectivity necessitated by the systematic process (Hammersley, 2001). For cases partially involving university spin-offs, they were acceptable for the review if the findings did not point to the exclusive specificities of

academic entrepreneurship, e.g. management and legal aspects of university-owned intellectual property rights deployed by academic-owned firms.

The terminology pertaining to knowledge sourcing also varied in the selected studies. Not all texts were consistently direct with the terms such as knowledge sourcing, access, or acquisition. In many cases, collaboration in knowledge-intensive projects was used to indicate a firm's action in obtaining external knowledge and they thus served as proxies. The judgment was then involved in determining whether the access to or the acquisition of knowledge provided the main rationale behind such collaborations.

### **3.4 Data extraction**

Data extraction form helped organise the findings and facilitate data synthesis. The extraction form (Table 3-6) was designed according to my previous exposure to the field, the preliminary reading of selected material, along with the general requirements in referencing and citation.

**Table 3-6 Data extraction form**

Extraction fields	
<b>Bibliographic information</b> Authors Year Article title Journal/book title Volume Issue Pages Editors (if applicable) Publisher (if applicable) Location of origin (if applicable)	
<b>General information</b> Main purpose Methodology Population studied Theoretical perspectives (if any) Main findings	
<b>Contextual information</b> Geographical location Industrial sector	
<b>Characteristics of knowledge sourcing</b> Source Relationship Mechanism	
<b>Knowledge base characteristics</b>	
<b>Role of public policy (if applicable)</b>	

*\*Defined as the technology underpinning a firm's main product/service offerings*

### 3.5 Data synthesis

In the simplest sense, the data synthesis was primarily guided and constrained by the availability of information garnered from the literature search. Upon the preliminary reading, I identified the geography of knowledge sourcing as the overarching dimension addressed by the vast majority of final papers. Having anchored the review in a broad theme, I then attempted to see whether there were factors or antecedents mentioned by the authors in relation to knowledge sourcing. In the formulation of sub-themes, I tried to reconcile the two notions—the specificity of the particulars which was the value of empirical work and the tidier coherence of aggregated accounts which would inform further research and practice. Building upon my awareness of a number of constructs discussed in the literature, I chose to focus on what I termed the



“conditional dimensions” that influence the knowledge sourcing of SMEs. These dimensions were predominantly external to the firms. I acknowledge that there could be other ways to conceptualise the phenomenon, for example, by basing on strategic orientation, business models or the characteristics of owners/managers. The main reason for my choice, first and foremost, rested on its applicability to most of the papers included. The findings (Chapter 5) were therefore categorised according to the characteristics of the industrial knowledge base, the market, peers and the local condition, and the institutional environment. It should be noted that as a consequence of the synthesis, some loss in contextual specificities was to be expected from the start (Hammersley, 2001).



## 4 OVERVIEW OF THE SELECTED SOURCES

This chapter provides a descriptive overview of the final collection of sources selected for the literature review. All of the sources included are from peer-reviewed journals, resulted from systematic database search, cross-referencing and recommendations. Certain characteristics such as publication titles, their associated disciplines, year of publication, as well as some contextual information of the selected studies are covered.

The numbers reported in this chapter are raw counts. I refrain from reporting percentages or other statistical figures because the small base size (34 papers) is unlikely to be sufficient for meaningful statistical insights. As a result, any quantitative comparison should be taken as directional and indicative.

More details on each of the selected papers can be found in the Appendix.

### 4.1 Publication characteristics

Table Table 4-1 contains the list of the publication titles included in the review along with the rankings prescribed by Cranfield School of Management (Cranfield School of Management, 2011). Two journal titles making the largest contribution of four articles each are *Entrepreneurship and Regional Development* and *Research Policy*. Those contributing three articles are *European Planning Studies*, *Journal of Technology Transfer*, and *Regional Studies*.

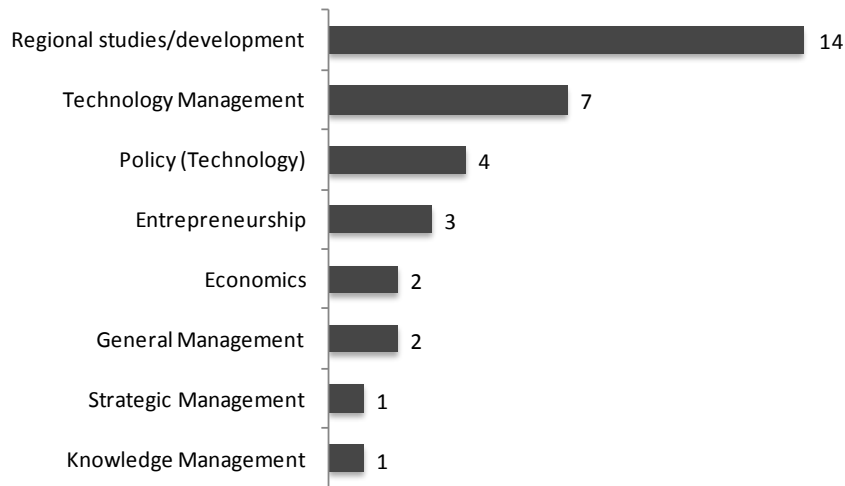
It can be seen that a large part of the featured papers are from journals whose rankings are not available from the Cranfield ranking system. Also observable is the absence of top-tier US-based mainstream management journals. Although one article from *Organisation Science* features in the review, it appears to be an exception rather than the norm.

**Table 4-1 Sources by publication title and ranking**

Title	Number	Ranking
European Planning Studies	3	No rankings available (n=11)
Journal of Technology Transfer	3	
Growth and Change	2	
Economic Geography	1	
International Entrepreneurship and Management Journal	1	
Journal of Knowledge Management	1	
European Journal of Innovation Management	1	1* (n=2)
International Journal of Entrepreneurial Behaviour & Research	1	
Entrepreneurship and Regional Development	4	2* (n=7)
Annals of Regional Science	1	
Industry and Innovation	1	
Technology Analysis & Strategic Management	1	
International Journal of Technology Management	2	3* (n=6)
British Journal of Management	1	
Journal of Evolutionary Economics	1	
Long Range Planning	1	
Small Business Economics	1	
Research Policy	4	4* (n=8)
Regional Studies	3	
Organisation Science	1	
Total	34	

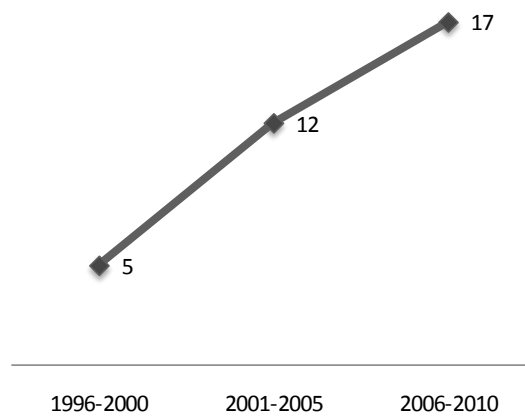
Figure 4-1 summarises the publication domains of the papers. They are based on the orientation of a journal with which an article is associated. A significant portion of relevant papers fall into the field of regional development and technology management/policy. The association with technology is by design, as technology-based SMEs form a part of the phenomenon of interest. The large share of regional studies, on the contrary, emerged out of the search and selection results. These papers in regional studies have inevitably impacted the central theme of this systematic review. The interest in geography or spatial proximity is also found in technology management literature. The field of technology policy contains only one publication, which is *Research Policy*, whose four papers included are country-specific in their characters.

Entrepreneurship and economics are also important contributors, in line with the SME-centric review question. Despite knowledge also being the main focus, relevant articles from strategic management and knowledge management are challenging to come by.



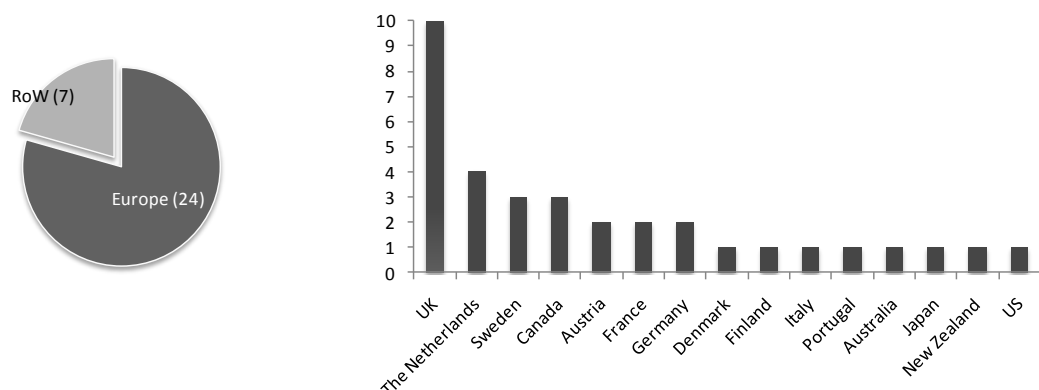
**Figure 4-1 Sources by publication domain**

Figure 4-2 shows that the empirical research in inter-firm knowledge sourcing has seen the rise in number over the past 15 years. While this may seem a delighting trend for those interested in empirical research, a closer look is warranted. Of the five articles published before 2000, four are from four-starred publications (three from *Regional Studies* and one from *Organisation Science*) and one is from a three-starred (*International Journal of Technology Management*). No articles from *Regional Studies* published after 2000 appear in the review. The only four-starred journal contributing more recent papers is *Research Policy*.



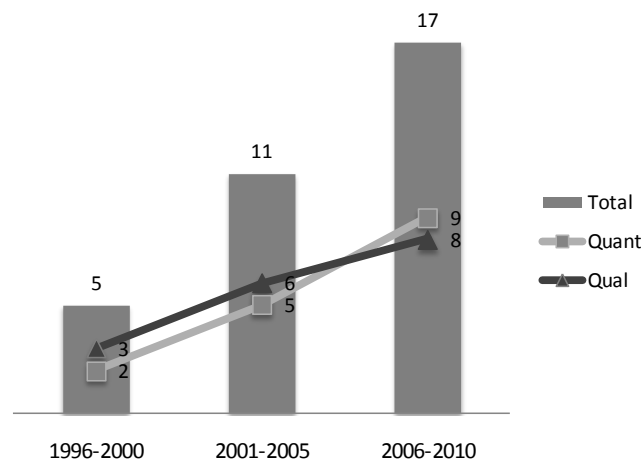
**Figure 4-2 Sources by publication period**

While there is no key author emerging from the collection, the studies featured in this review are mainly from authors located in European countries, as presented in Figure 4-3, with the dominance of UK-based researchers. This may be an indication of how the interest in the subject is distributed unevenly across the globe. However, this is not to say that the general interest in inter-firm networking or knowledge-based collaborations among firms is lower in the US as the prominence of certain US-based key figures in the area points to quite a contrary. Due to the nature of research question, the distribution reported here only pertains to empirical research in a very specific domain. The observed geographical imbalance may point to the differences in the modes of inquiry more than anything else.



**Figure 4-3 Sources by first author's country of affiliation**

Figure 4-4 shows that the share of qualitative and quantitative analytical orientations adopted has remained balanced over time. I chose to report on analytical orientation, i.e. how the data have been used, rather than the data collection method itself because a number of studies collected multiple types of data but most of their analyses and presentations can be seen as mainly qualitative or mainly quantitative. It should be noted that there is an omission of a mixed orientation in one study (Lissoni, 2001), bringing the total number of studies reported in Figure 4-4 down to 33.



**Figure 4-4 Relative share of qualitative and quantitative research by period**

The pattern of research methods adopted in research published in journals of different rankings is demonstrated in Table 4-2. However, this should not be taken as indicative of the relationship between the methodology choice and acceptance due to the limited number of featured articles.

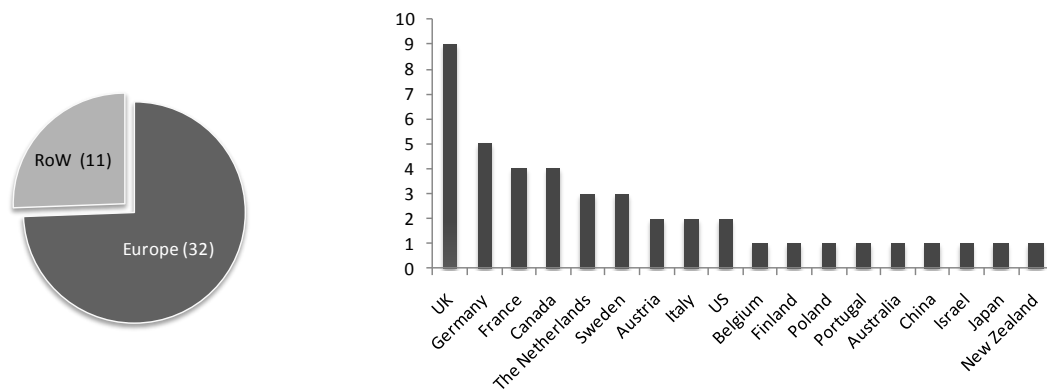
**Table 4-2 Research method by journal ranking**

Method	Ranking				
	None	1*	2*	3*	4*
Quantitative	5	0	4	4	2
Qualitative	6	2	3	2	5

## 4.2 Contextual characteristics

Reflecting the country affiliation of first authors, Figure 4-5 also shows the heavy representation of European countries as the studied context, again with the UK dominating. The count is based on the number of a given country's inclusion in a study, both in single and multi-country research. Among those with one representation, Belgium and Israel are parts of two different multi-country studies.

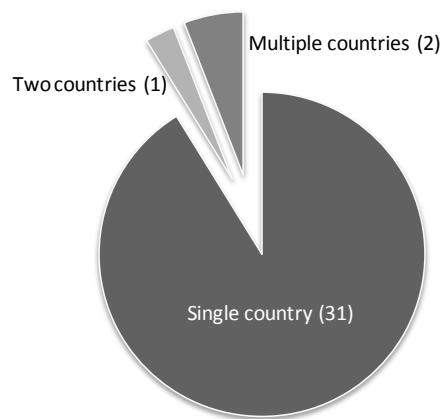
The high proportion of European context should give away some caution in the interpretation of results, as the national characteristics may have had significant influence on the empirical findings.



**Figure 4-5 Sources by country represented**

As illustrated by Figure 4-6, the vast majority of the studies included here, 31 out of 34, are based on a single country. Direct comparative study is very rare, with only one comparing France and the UK (Mason, Beltramo and Paul, 2004). There is certainly not sufficient information to speculate whether this trend is a reflection of scarce interest in comparative studies, the challenges associated with multi-country data collection, or the contextually embedded characteristics of the phenomenon.





**Figure 4-6 Sources by the number of countries studied**

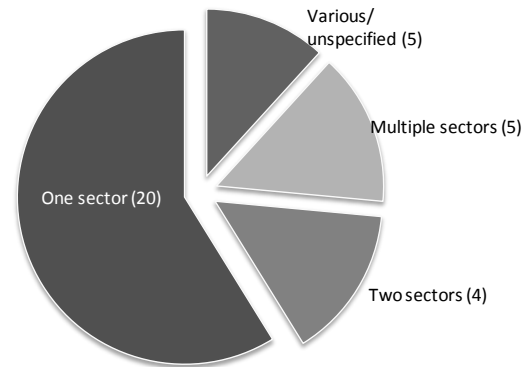
ICT and biotechnology are the two most frequently studied sectors, as presented in Table 4-3. There are clarifications to be made in the meaning of “manufacturing”. A number of studies identify their sector of interest as manufacturing but few of them provide an exhaustive list of different business focuses within manufacturing. Studies that encompass multiple sectors, often of non-manufacturing nature, are generally more precise but the preciseness has rendered the list rather fragmented.

**Table 4-3 Sectors represented in the selected papers**

Sector	No. of times represented	Sector	No. of times represented
ICT	10	Water treatment	1
Biotechnology	9	Filing equipment	1
Manufacturing	8	Design technology	1
Electronics	6	High-tech systems	1
Industrial chemistry	2	Automobile	1
Medical technology	2	Nano- and micro-systems	1
Service (unspecified)	2	Materials	1
Food	1	Technology consulting	1
Industrial furniture	1	Pharmaceuticals	1
Aerospace	1	Machinery	1

As displayed in Figure 4-7, the majority of studies are based on one sector, obviously ICT, biotechnology or manufacturing. It should be noted that, like manufacturing, ICT and biotechnology are both umbrella terms and neither of which can be considered homogeneous. There are also a number of studies whose sectors of interest are not

explicitly stated. The majority of these studies deal with innovation systems or a certain region in a collective manner.



**Figure 4-7 Sources by the number of industrial sector(s) studied**

### **4.3 Implications on the systematic review**

The overview of the selected literature reveals some important implications on the review.

- The significance contribution of regional studies, with frequent regional development undertone, may lead to certain collective direction and tone of which I, a reviewer, should have an awareness.
- This review is interested in empirical accounts which are influenced and constrained by the institutional environments. The synthesis could be impeded by the dearth of multi-country studies that may otherwise offer logic check. Further sensitivity should also be the case for the predominant representation of the European contexts.
- The interest in empirical findings brings forward another point of inevitable fragmentation in the real-life contexts presented in each piece of research, often without much theoretical assistance. Choices have to be made regarding how the relevant data will be selected, presented, and analysed. How the

review question is to be answered hinges on three things—the extant literature, how the pool of literature is conceptualised, and the appreciation of limitations attached to it.



## 5 FINDINGS

This chapter contains the empirical findings garnered from the selected literature. The question of how SMEs source external knowledge in their networks can be discussed in a number of different ways. For the purpose of this systematic review, the extant literature obtained through the search protocol (Chapter 3) gives rise to the overarching theme of geography of knowledge sourcing, i.e. the spatial characteristics of firms' interactions with knowledge sources.

From the selected texts, I have identified four generic conditional dimensions upon which a spatial pattern of knowledge sourcing can be observed. The dimensions comprise the followings.

- Section 5.1 The industrial knowledge base
- Section 5.2 The market
- Section 5.3 The peers and the local condition
- Section 5.4 The institutional environment

A number of factors facilitating knowledge sourcing will also be covered in section 5.5. Within each dimension, the knowledge sourcing can be regarded as generally taking place in three types of relationship; vertical (with other firms along the supply chain, such as customers and suppliers), horizontal (with firms in the same level of supply chain, including competitors), and institutional (with public establishments intended for knowledge provision).

The patterns observed are termed general tendencies in order to signify their directional and tentative nature. I would caution against statistical reading from the findings presented here as the overall number of texts could only ascertain that any statistical inferences based on them will be misleading. In addition, among all the texts selected, only few give discernible explanations on both the actions of SMEs and the conditions to which they are subject, further reducing the number of texts directly applicable to each conditional dimension. Since caution is advised statistically, the

findings will be presented in relation to their empirical context to allow analytical interpretations.

Another point should be made regarding the phenomenon of interest. The main concern of this section is on how firms source knowledge as they currently do, not how firms may *best* source knowledge. Therefore, the general tendencies reported below are based only on the interplay between each conditional dimension and firms' activities. Performance outcome (e.g. innovativeness) or consequences of knowledge sourcing do not factor in this instance.

## **5.1 The industrial knowledge base**

The question of knowledge sourcing may not be answered without the consideration of knowledge itself. I construct this section around the firms' industrial knowledge base (Asheim and Coenen, 2005; Asheim and Gertler, 2005) which is the knowledge that underpins the product/service offerings rather than the knowledge being transferred itself for the reasons discussed below.

One way to characterise knowledge is along the tacit-codified continuum. This property is relevant but would be problematic given the nature of the selected articles. First, it is highly arbitrary as it invites the debate of what should be classified as tacit knowledge, codified knowledge, and how the latter differs from information. Second, it does not reveal the knowledge content. Third, it is unlikely to be the primary concern of firms as they source knowledge. Instead, the content and the purpose inform firms of the codifiability of the knowledge they wish to acquire, not the other way around. Basing the phenomenon on the content of the transferred knowledge has its own challenge. Few studies are explicit in their accounts of what knowledge is being sourced. The diversity of firm-specific knowledge requirements may have prevented the higher degree of explication.

I chose the industrial knowledge base as a means to address this issue. Here, the basis is on the content of knowledge underpinning a firm's offering. It follows that the knowledge of interest is predominantly technical. Using the industrial knowledge base

has some practical benefits as it lends itself to examining technology-based firms and sector-based conceptualisation. The knowledge base also reflects the orientation and the broad nature of capabilities held and required by technology-based firms. It influences the sources from which a firm accesses external knowledge as well as the geographical properties of knowledge sourcing.

The findings are discussed in relation to two generic types of knowledge—analytical and synthetic. The categorisation is based on the combination of tacit and codified knowledge which influences the types of skills, organisational characteristics, and institutions required for knowledge creation and diffusion. Analytical knowledge can be regarded as science-based. Formal scientific knowledge base and organisation are essential, generally involving universities and basic research institutions. Codification and documentation of the knowledge produced is the norm. Prevalent examples are biotechnology and general information technology. Synthetic knowledge, on the other hand, is more engineering-based. It involves combination and application of existing knowledge for practical purposes, for example, in manufacturing and production. Here, tacit knowledge plays a more important role, as trial and error can be essential for development processes. This mode of knowledge production is more feasible in existing firms, as innovation is likely to be incremental and less disruptive to their routines (Asheim and Coenen, 2005; Asheim and Gertler, 2005).

### **5.1.1 Synthetic knowledge base**

Here, I present the different dynamics of knowledge-based dynamics of two clusters—the electronics cluster in Oulu South which is a remote area in Finland (Virkkala, 2007), and the Motor Sport Valley in the south of the UK (Pinch and Henry, 1999).

The Oulu South cluster provides a very rare example of an endogenous cluster. Most sample firms in the cluster operate in the second or third tier of Nokia's network, supplying mainly to regional customers who are considered the most important knowledge source. The second most important knowledge source is the local polytechnic college which also supplies the workforce to the cluster. Inward migration

by outside firms has been extremely rare. This self-sustaining dynamics is in accordance with the technological needs (the specifications of required components) which are relatively well-defined and move on the slower path of change. The incremental improvement is brought about by horizontal learning through observation and imitation which are attainable in such a close, homogeneous network. However, in the face of changes in customers' requirements, Oulu South firms also reportedly seek collaboration with outside firms (Virkkala, 2007).

The situation is different in a faster-changing environment of the Motor Sport Valley which serves as a prime example of how spillovers induce spatial congregation. This cluster of race car firms and suppliers stemmed from the expertise in aviation engineering held in the region. The very nature of knowledge application in such products involves much trial and error, the outcome of which can only be observed with physical presence. The knowledge relationships of peer firms are overwhelmingly informal, resting on the inevitable spillovers interpreted from high workforce mobility, supplier interactions, performances of competitors, rumours and grapevine. The role of universities and research and technology organisations (RTOs) is not evident here. Fast, continuous improvements required in the business could be well beyond the capacity of one or few research institutions. Thus, keeping an eye on success and failure of competitors give away much clue for observers such that they are better informed to progress more rapidly in the product development. While secrecy is much desired by an individual firm, the need to observe rivals' attempts outweighs such concern. As isolation prevents information from leaking out, it also shields a firm from new knowledge. It is interesting that explicit knowledge sources such as trade journals or formal publications are not of prime importance in such setting, as they are unable to capture insights in a timely fashion (Pinch and Henry, 1999).

Both cases of synthetic-knowledge-based firms point to the importance of how the application, i.e. how knowledge manifests in final products, influences knowledge sourcing. Oulu South firms can afford to enjoy relatively more stability. The highly



dynamic Motor Sport Valley is characterised by relentless pursuit product performance which necessitates their constant alertness in knowledge search.

Another point worth noting from is how knowledge flows through individuals. The reach of these individuals then determines the geographical reach. The study of an Italian machinery cluster by Lissoni (2001) illustrates a more expanded scope. He observes that knowledge flows through key engineers, from each of whom an “epistemic community” stems, suggesting that knowledge does not flow freely “in the air”. The spatial scope of a community varies, depending on the location of suppliers and customers. This way, knowledge networks can extend geographically from key engineers, even though they themselves are still based within a cluster.

While the cases differ markedly in a qualitative sense, they exhibit some degree of co-location especially the first two. However, the trend should not be taken as confirmatory. A very important reason is that studies with enough information to be discussed here are framed in the context of an existing cluster. Other studies in a non-cluster setting do not provide sufficient information on the focal firms’ technological identities. More ways of inquiry other than cluster- or region-based should bring more understanding of the phenomenon.

### **5.1.2 Analytical knowledge base**

Of the selected literature, there are only two variations of analytical knowledge—biotechnology and ICT. Biotechnology, as a collection of technologies related to molecular biology and genetics, has a wide range of applications as do the engineering technologies. The findings in this area, though not without contradictions, tend to be rather coherent as the main focus is generally on the nature of knowledge (i.e. the science) itself instead of its application in the form of products.

#### **5.1.2.1 Biotechnology**

The most salient finding in the literature is that small biotechnology firms share a strong tendency to congregate around a research facility from which they source

knowledge (Cooke, Kaufmann, Levin and Wilson, 2006; Liebeskind, Oliver, Zucker and Brewer, 1996; McAdam and Marlow, 2007; Mohannak, 2007; Mytelka, 2004). Cooke *et al.* (2006: 116) posit that by locating in proximity to research labs and universities, firms benefit from time economies in that:

- They come to know of the latest developments before their official release
- There is more transparency in determining compatibility between potential partners
- The physical access of local inventions is relatively more convenient

All of the benefits mentioned are essential for new biotech ventures to move from exploratory phase of basic research to the exploitative phase of commercialisation.

A successful application of biotechnology typically encompasses a wide array of sub-disciplines. Therefore, it would be naïve to assume that firms look to the nearest university for a complete bundle of technical expertise. With the publications of scientific research, relevant research can be carried out in numerous locations around the world and small biotechnology firms do find access to research organisations abroad in their quest for best possible knowledge (Fontes, 2005; Hendry and Brown, 2006; Liebeskind *et al.*, 1996). However, despite the widespread of codification, tacit-local/explicit-global dichotomy does not fully apply. It is still the case that many new firms remain close to their “mother” laboratories to which they have prior relationship even though their technology bases are not directly related to those of the labs (Mytelka, 2004). It follows that apart from the economically objective purpose of obtaining technological input, other kinds of incentives may have come into play.

In a simple sense, being in a close proximity to the university, especially in a science park or an incubator, allows firms to become aware of and gain access to opportunities unknown to more distant counterparts, for example, an internal lecture. The grapevine effect has also been reported. Sometimes firms do not source knowledge directly from the university personnel but these people can disseminate the news of the latest development that would not easily escape the circle of personal contacts (McAdam

and Marlow, 2007). Social networks do not necessarily grant any new expertise to a firm but they certainly can expand the knowledge boundary. The fact that social networks are more evident in this sector than others invites a further question for the possible underlying logic.

Liebeskind *et al.* (1996) observe that new biotechnology firms rarely use market-based arrangements in knowledge sourcing. Instead, they rely on social networks of professional scientists who rest on shared norms, guarding against opportunism. The shared norm of scientist is more epistemic rather than geographical. By avoiding contractual costs, flexibility allows scientists/employees to source knowledge from numerous like-minded professionals in the public sector. Multiple collaborations can also give similar effects to those sustained by collective experiments in the Motor Sport Valley though the nature of scientific research dictates that the physical location of such experiments are lab-based. The significance of shared norm led firms to maintain a “university-like” (Liebeskind *et al.*, 1996: 439) organisational setting in order to encourage scientists/employees to work in their natural condition and allow interactions with their communities. The norms shared by scientists also contribute to the explanation as to why collaborations with large corporations often fail. Spatial proximity may reinforce a scientific community but does not preclude an epistemic community to interact from spatially-dispersed location.

Locating remotely from knowledge-intensive regions thus presents a major challenge for biotechnology firms. Fontes’s (2005) research shows that overcoming geographical isolation is possible but she states that it does not deny the importance of location, as the very small number of surviving firms indicates quite a contrary. For these firms, the key is in their ability to connect with important actors located in knowledge-intensive regions and develop alternative forms of proximity. She maintains that despite the convenience of ICT, “face-to-face contacts remain critical at various levels and temporary co-location is a requirement” (Fontes, 2005: 918).

### 5.1.2.2 ICT in comparison to biotechnology

ICT firms tend to use universities and RTOs differently than do biotechnology counterparts. Biotech firms mainly use the university research to counter uncertainty and long horizon in product development. ICT firms rely less on such knowledge but they tend to use universities for recruitment purposes (McAdam and Marlow, 2007; Mohannak, 2007). Perhaps with a more applied nature of their businesses, ICT firms tend to place more importance on in-house R&D and vertical relationships for which customers are the most important knowledge source. In Mohannak's (2007) research into an ICT cluster in Australia, local networking are not perceived as important by ICT firms in spite of a world-class research lab in the vicinity. ICT firms use more of communication technology in networking rather than seeking local collaborations. Peer contacts are thus normally located outside the home region. Informal contacts are initiated by professional events and meetings rather than spatial proximity.

*Industrial knowledge base: General tendency from the literature*

*Both cases with synthetic knowledge focus show a pattern of co-location, characterised by shared understanding of the local context as well as horizontal learning and competition although they differ in the observed intensity of inter-firm dynamics. Caution is strongly advised in affirming this pattern, as all studies are cluster-based and two of which represents very rare cases.*

*The cases with analytical knowledge base show some differences between two broad disciplines—biotechnology and ICT. Biotechnology firms tend to congregate around a basic research facility even when their technology base is not directly related to the anchor laboratories although this does not limit the biotechnology firms' ability to network extra-locally. ICT firms tend to use the universities and RTOs for recruitment rather than to obtain knowledge. Inter-firm relations in ICT normally spans over the perimeter of the home region.*

## 5.2 The market

Relationships with customers, followed by suppliers, are found to be the most important sources of external knowledge for the vast majority of the studies featured in this review. Customers and suppliers are generally not confined within a region. The market, i.e. the physical presence of customers, may be the most globalised of all the conditional dimensions.

The economic importance of customers plays an important role, as they are instrumental in firms' product development (Dankbaar, 1998). The geographical pattern of knowledge sourcing reflects the location of market. Export-oriented firms source knowledge extra-locally whereas firms whose customers are mainly domestic source knowledge more locally (Britton, 2004). A very striking relationship of the market location and knowledge sourcing is illustrated by Davenport (2005) in her study of New Zealand high-tech firms. Firms internationalise in absence of domestic markets as more than 80% of the sales of the sample firms comes from export. Knowledge sourcing activities are thus heavily international, with the main contact being customers and distributors local to foreign customers. In contrast, the Oulu South cluster (also discussed in 5.1.1) serves almost exclusively to regional customers. Their remarkably endogenous knowledge sourcing corresponds accordingly (Virkkala, 2007).

In addition to the physical location of market, firms' strategies in product offerings also influence their knowledge sourcing. As is often the case, SMEs tend to lack the economies of scale and are inclined to customise. Davenport (2005) observes that customising to niche markets intensifies the relationship firms have with customers and distributors, thereby strengthening the international focus of knowledge activities. She also speculates that spatial proximity may be suitable for a lower level of customisation. Tolstoy (2010) compares firms undertaking an international product venture (a major overhaul of existing product aiming at existing markets) and an international market venture (a minor product change aiming at new markets). It follows that product venturing requires certain competences not internally available to the firm, necessitating a new frame of technological composition. They therefore seek

technological knowledge from partners/suppliers for product development, and key customers for prototype testing. In a market venture, the knowledge sought concerns mainly the market structure and customer preferences. The knowledge sources are thus predominantly market-based, such as distributors and local market researchers.

For certain industries, the market may require physical presence of firms, rendering the knowledge sourcing localised. In the Aberdeen oil complex, Mackinnon, Chapman and Cumbers (2004) demonstrate that spatial proximity remains instrumental as it enables responsiveness in service.

If you are in the oil and gas business you need to be in Aberdeen, particularly in the service part of the industry.

(Interview quoted in Mackinnon *et al.*, 2004: 93)

Aberdeen is a highly localised cluster of oil-related activities for the North Sea. The location itself is a platform for knowledge access. The physical presence, i.e. “being seen”, is crucial both for business and technological relationships. It helps establish connections, increase social stature, and in turn, ease the knowledge access. Like Pinch and Henry (1999), the secondarily important sources are those providing explicit knowledge which are easily accessible. The Aberdeen oil complex is a place that informal trade knowledge and rumours play an important part, even though it has come a long way from when everyone knew everyone. This is not to say that Aberdeen is self-contained, only that the locale has evolved to be a very important node of the global oil industry.

#### *The market: General tendency from the literature*

*The market is perhaps the most straightforward conditional dimension. Since customers generally are the most important source of knowledge for the firms, it follows that at least a part of a firm’s knowledge sourcing reflects the geographical location of its customers. The necessity of the physical presence of firms in a given location can determine the distance and the spatial characteristics of customer*

*relationships. In addition to the location, a firm's product/market strategy influences both the sources and the knowledge required for the task.*

### **5.3 Peers and the local condition**

Firms can only collaborate with entities that exist. The local existence of peer firms and the local/regional competence in technology influence a firm's spatial connections. Both will be discussed in conjunction.

Davenport (2005; also in Section 5.2) attributes the dearth of intra-sectoral R&D linkages and the rapid internationalisation strategy of New Zealand innovative firms to, first and foremost, the lack of similar firms in their home country over the international market opportunities. When such linkages do happen, they are based on the complementarity of product/service offerings rather than geographical proximity which is either unattainable or technologically sub-optimal. The international exposure of these firms propelled their orientation towards the global market.

Pressure from external organisations can induce firms to source knowledge more actively (Jones and Macpherson, 2006). The spillovers are observed in regions with a sufficient density of firms functioning in the same industry including competing firms, buyers and suppliers as demonstrated in the Motor Sport Valley (Pinch and Henry, 1999: section 5.1) and the Aberdeen oil complex (Mackinnon *et al.*, 2004: section 5.2). However, both cases suggest that a mere spatial aggregation may not be sufficient for firms to benefit from spillovers. The shared perception of the locale's industrial importance is remarkably evident in both cases. The same location-specific attitude does not come across to the same degree in the research on institution-based knowledge-intensive locations (Tödtling and Kaufmann, 2002).

It should be noted that the existence of peers can be perceived differently especially in areas with less markedly-identified industrial identity. As discussed by Tödtling and Kaufmann (2002), smaller, less innovative firms simply lack awareness of potential network. Larger, more innovative firms, on the other hand, tend to have better awareness but adequate partners are often challenging to come by.

The presence of peers is often observed with a sufficient level of technical competence of a region although the causal relationship of both notions cannot, or probably should not, be assigned with certainty. In the study of a less competitive region of England, Huggins and Johnston (2009) found that more innovative firms sourced knowledge from outside of the region to a larger extent than do less innovative firms. In this context, large firms do report collaborations with regional universities. The spillovers in the traditional sense are questionable considering inadequacies of small firms that result in the lack of incentives for large firms to cooperate within the region.

The active presence of regional knowledge organisations has an effect on the relative importance of local knowledge sourcing of a firm's (van Geenhuizen, 2007). In Ottawa where many public agencies and industrial associations reside, knowledge activities are distinctively local (Doloreux and Mattson, 2008). While firms do source knowledge from overseas actors for all types of interaction (vertical, horizontal, institutional), local milieu plays a very important role especially, in case of research universities and laboratories. The presence of knowledge-based organisations in the Vienna software cluster also sees the similar pattern of knowledge sourcing (Trippel, Tödtling and Lengauer, 2009). Untraded interdependencies are observed in this cluster. Firms are found to prefer informal means knowledge sourcing which allow more flexibility and entail less cost of establishment than do contract-based relationships.

Predominance of informal relationships among local peers and institutions concurs with the speculation made by Clifton, Keast, Pickernell and Senior (2010) that informal knowledge interactions at the regional level can be more effective compared to the formal means. De Bernardy (1999) finds that some SMEs favour personal relationships when it comes to networking, even sometimes at the expense of technical competences. Embeddedness in the regional networks may also allow firms to better gain control over the relationships and to some extent limit the risk of opportunism (Lechner and Dowling, 2003). An interesting point is made by Sternberg (1999) that personal relationships would be especially helpful if they existed before any specific project is to be carried out.



In a network that is sufficiently dense and localised, high turnover of new venture formation and staff rotation facilitate knowledge flow in a spatially-proximate group of similar firms (De Bernardy, 1999; Buenstorf and Fornahl, 2009; Pinch and Henry, 1999; Virkkala, 2007). Especially in a dense spatial network, the competence and suitability of a given employee is readily transparent to other members of the community. Hiring personnel away from a competitor is thus one means to gain access to knowledge in such setting (Pinch and Henry, 1999) although the usefulness of a new hire may be limited if the knowledge base of each firm is highly specialised (Lissoni, 2001).

As mentioned, the causal relationship between the institutional condition of a locale and the presence of firms within it is not easily realised. A relationship that is more readily visible is that the complementarity required between a particular set of skills available in the region (the firms) to benefit from scientific activities (universities and RTOs) (De Bernardy, 1999).

*Peers and the local condition: General tendency from the literature*

*Without local peers, firms tend to be forced to develop distant knowledge relationships. The existence of local peers may give rise to localised knowledge interactions although it should be noted that such condition alone is unlikely to be sufficient. The shared perception of the locale's industrial significance and/or the presence of institutional support in the region are important. In the absence of both, firms source extra-regional knowledge and bigger firms are likely to be more efficient.*

## **5.4 The institutional environment**

The host country of SMEs can have a great influence on how SMEs source external knowledge. One may see two further dimensions of how a country may contribute to this—the technological competence and the institutional environment. While the previous section deals with the conditions specific to a region, this section emphasises more on the overall picture of a country in relation to public policy. Although heterogeneity is expected in any country, for a practical purpose of this review, a

country will be dealt with in a broad sense as a politico-legal entity. Moreover, public policy is generally national in its character.

Among a handful of papers reviewed, it seems that France, as a country with more developed technical competence and heavier state interventions, yields more favourable results toward spatial coherence in networking and private-public collaborations (De Bernardy, 1999; Mytelka, 2004). The same also applies to Japan (Fukugawa, 2006) and Germany (Sternberg, 1999). Mixed reactions are found in the UK (Hendry and Brown, 2006; Huggins and Johnston, 2009), whereas the only article representing a less-advanced country appears dismissive toward the spatial proximity (Lorentzen, 2007).

Mytelka (2004) found a strong tendency to cluster among French biotechnology firms, all of whom have relationships with universities and RTOs. The significant importance of public organisations is also shared by De Bernardy (1999) and Sternberg (1999) whose work strongly supports the knowledge spillover theory. However, state affinity may have an adverse effect to private sector knowledge dynamics, as possible inertia in inter-firm collaborations is observed by Mytelka (2004). Mason, Beltramo, and Paul (2004) address this concern in their inter-country comparison of the knowledge dynamics in the optoelectronics industry in France and Britain in relation to labour market. The differences are most pronounced in the horizontal and institutional relationships. Labour mobility is highly limited in France compared to that of Britain. Since institutional relationships are formed through firms' employees, they tend to be more stable in France though it should be noted that they also tend to take longer to initiate. In Britain, on the other hand, scientists and engineers relocate more freely and bring with them their institutional contacts into new companies. This helps broadening the repertoire of knowledge sources available to a British firm. A country's norm in hiring practice can thus have a profound effect on how firms source knowledge. Knowledge flow by means of workforce mobility as mentioned in Pinch and Henry (1999) is therefore much less common in France.

Although no causal relationship is made, this trend reflects institutional support in each country. French organisations receive more direct support whereas British universities and RTOs respond to financial pressure by seeking private sector collaboration, coinciding with the more economically-driven dynamics in Britain both in private-public and private-private interfaces. The authors regard Britain as more conducive to firms' adaptation in the fast-changing environment though possibly at the expense of strategic technological development of the country.

In the study of Polish manufacturing firms, Lorentzen (2007) contends that knowledge sourcing is mainly global, not regional. No knowledge source is more important than the customers abroad. While acknowledging the contribution of the local pool of skills and entrepreneurship according to the territory-based innovation theory, she states that:

Local networks among firms, as these theories maintain, did not exist in the case studied here. It can be suggested that the geographic proximity among firms in the locality was not followed by economic and technological proximity, thus considering the local knowledge exchange among economic actors futile.

(Lorentzen, 2007: 483)

This echoes the observation made in the previous section, that spatial aggregation in itself is not sufficient for localised knowledge dynamics. Further observations can also be made on Lorentzen's findings. On the one hand, the predominantly global nature of knowledge sourcing may seem similar to Davenport (2005) in which firms engage in cutting-edge innovation customised to niche markets overseas. On the other hand, she found the local recruits to be perfectly sufficient for the technological requirements is somewhat incongruent. Together with the absence of institutional support in firms' knowledge sourcing and the highlight being placed on easily accessible media (e.g. internet and trade journals) as the important global knowledge source, one may question the quality of knowledge obtained. This may reflect the institutional inertia in Poland. It should be of no surprise that firms have incentive to source the best knowledge, hence the extension from their home region discussed throughout this

chapter. However, what is not clear from this study is whether relevant knowledge is available to the firms to begin with.

Another interesting observation is Lorentzen's (2007) sampling choice which did not take into account a sample firm's association with clusters, as opposed to cluster-based studies reported in section 5.1 (Pinch and Henry, 1999; Virkkala, 2007). The way in which the knowledge network is studied therefore deserves a careful consideration in further empirical studies.

Policy instruments have also been studied as a means to provide SMEs with access to knowledge sources, the most common of such instruments is a structured space, i.e. incubators and science parks (e.g. Cooke *et al.*, 2004; Lindelöf and Löfsten, 2004; McAdam and Marlow, 2007). Again, the intensity and direction of state influence on the institutional arrangement in and around a structured space can result in a certain level of spatial containment as well as the national imbalance in the distribution of knowledge-intensive locales (Zhu and Tann, 2005). Kirkels and Duysters (2010) highlight the knowledge brokerage roles that public organisations can play. Brokers from public and science sectors, especially those with proven track records, have the advantage of impression of being free from commercial partiality.

However, it should be appreciated that public policy is not an absolute prerequisite for success. Buenstorf and Fornahl (2009), along with Pinch and Henry (1999) have discussed the instances where firms engage in highly dynamic knowledge networks with only modest institutional support. In both cases, the dynamics are sustained by "a common industrial purpose and shared cultural norms and values" (Pinch and Henry, 1999: 826).

#### *The institutional environment: General tendency from the literature*

*To some extent, this conditional dimension shows that geography depends on geography. Research conducted in countries with closer state influence tends to show more positive results toward the coherence of spatial proximity and localised knowledge activities, both among firms and between firms and public institutions. A*

*country with less state support and perhaps technological competence, though represented only by one non-cluster-based case, is less likely to see favourable results of spatial proximity on inter-firm learning.*

## **5.5 The enablers**

In addition to the conditional dimensions, there are a number of enablers facilitating the knowledge access. It can be said that these enablers in themselves do not directly influence geographical decisions of managers in knowledge sourcing but, rather, they may influence the quality of the outcome.

Shared norms are evidently important in the studies reviewed (Liebeskind *et al.*, 1996; Mackinnon *et al.*, 2004; Pinch and Henry, 1999). They go together with the common interests and interpretive frameworks discussed by Werr, Blomberg and Löwstedt (2007). These notions lead to social embeddedness important for legally independent firms connected by networks. They help reduce uncertainty in the expected outcomes which would otherwise have to be enforced by contractual agreements (Liebeskind *et al.*, 1996).

In addition to the well-accepted importance of absorptive capacity (Julien, Andriambeloson and Ramangalahy, 2004) based on the similarity of technology focus and operating conditions (Virkkala, 2007), excess capacity may also have a facilitating role for collaborations. Larger SMEs tend to be more proactive in networking and knowledge sourcing (Dankbaar, 1997; Tödtling and Kaufmann, 2002). Smaller firms, even the less networked ones, do appreciate the value of inter-firm relationships (Mohannak, 2007). The excess capacity may influence a firm's perception of its priority (Werr *et al.*, 2007) that classifies knowledge as nice to have or essential.

*The enablers: Short remarks from the literature*

*The selected papers reveal a few factors that can facilitate knowledge sourcing in networks which are shared norms, absorptive capacity, technological complementarity, and excess capacity.*

## **6 DISCUSSION**

In this chapter, I discuss how general tendencies reported in chapter 5 may help us understand the spatial properties of knowledge sourcing by technology-based SMEs. The main argument is that the general tendencies are useful but not in themselves sufficient to answer the review question without further contextual sensitivity.

Following the main argument, I start the chapter by acknowledging the limitations arising from both the literature itself and from my engagement with the systematic search and the synthesis process (section 6.1). Then I bring forth three issues that should factor into the interpretation of the general tendencies in other contexts (section 6.2). Based on the caveats, I discuss how we may be able to better understand the geography of knowledge sourcing in relation to the general tendencies, their limitations, and the further contextual sensitivity (section 6.3).

This systematic review has exposed some questions that remain to be answered; a few of them are mentioned in section 6.5. I also offer some policy recommendations, or more precisely, policy warnings in section 6.4. The chapter then ends with my account on the personal learning experience from the systematic review process.

### **6.1 Limitations**

Any effort to make sense of the findings would be very difficult without having first acknowledged the limitations inherent in the content.

The first limitation concerns the availability of the material. I have neither the intention nor the capacity to claim the exhaustiveness of the coverage which I have made for this systematic review. The implications of the “perceived” limitedness are two-fold. The upstream concern is that while I have tried to the best of my knowledge to conduct a search as thoroughly as possible, there is not much I could possibly have done in terms of figuring out what could have been. Although I have made a case to keep the search strategy as simple and broad as possible for the concern of a more structured approach possibly leaving out relevant materials, another person may be

able still to come up with a different strategy. The downstream concern is that the selected articles, which are not many, are far from being able to allow much confidence in the interpretation.

While the first limitation is with regards to the sheer number of the articles, the second pertains to a more qualitative nature of the material. The concern is that I could only be as precise as permitted by the selected texts, i.e. by how and for what purpose were been written. Focusing on empirical literature presents a challenge in that all findings are grounded in context, whose level of articulation varies. Literature streams in management, economics, and public policy emphasise different constructs and adopt different ways of presentation. Some of the articles may lend themselves more to this specific review process than the rest.

I have consciously tried to base the presentation of Chapter 5 solely on the factual information garnered from the literature. It is less of counteracting a researcher's bias than of my attempt to give the readers the clarity of what can be found in the literature in keeping with the basic intention of a systematic review to be "evidence-based". Still, the conceptual organisation was my product and, even on its own, led the portrayal of the story in a certain way. The third limitation of this systematic review is therefore in the choice I made in the synthesis process.

## **6.2 The disclaimer on general tendencies**

Differing from a large amount of work asking how spatial proximity impacts knowledge activities in a locale, this systematic review takes a reverse position of how certain factors influence spatial dimensions in knowledge sourcing. The findings so far answer the question by revealing general tendencies according to four conditional dimensions. General tendencies themselves are derived from the simultaneous presence of a conditional dimension and a spatial pattern of knowledge sourcing. Still, I regard the answer as partial because the resulting understanding is from an observer's perspective. The usefulness of the general tendencies is in their aid for anticipating patterns in an aggregate level. Nonetheless, the original intention I had was to

understand firm-based decisions in knowledge sourcing and we have moved very little towards that direction based on the general tendencies alone. This issue may have arisen from my conceptual categorisation, for how the dimensions are expressed as “conditional” gives a strong impression of determinism. However, as discussed in the data synthesis section, this way of conceptualisation is based primarily on feasibility. Therefore, my impression of the extant literature is that it is, by and large, dominated by the network perspective.

There have been instances throughout this document in which I have warned against inferring causality, let alone generalisation. What general tendencies provide is a good starting point. In our case, they are inevitably accompanied by a large dose of caveats as they stand on only few pieces of research. A more ideal situation in which a much larger number of relevant texts can be located may allow more confidence in drawing a pattern. Still, the main argument for this section is that a better refined understanding of the phenomenon takes a coupling of general tendencies and contextual sensitivity. I start the discussion around three points of consideration that should be taken into account when reading into the findings.

### **6.2.1 The complexity of ideal-type factors**

The first thing to consider is that the findings are based on the ideal-type factors, most notably for the case of analytical knowledge base. In section 5.1.2, the observed patterns of biotechnology and ICT firms, both are thought to rest on analytical knowledge, may reflect the internal variation of this knowledge type. Moreover, the ideal dichotomy of industrial knowledge base does not capture another type of knowledge that may draw firms together spatially.

Two disciplines regarded as analytical-knowledge-based (Asheim and Coenen, 2005; Asheim and Gertler, 2005) are general ICT and biotechnology. From admittedly limited information, we see much less tendency of ICT firms to congregate around an anchor research facility. While both are categorised as being of the same ideal type, the physical properties of knowledge production in biotechnology and ICT markedly differ.



A dedicated laboratory space is a prerequisite in biotechnology, while the same is not always the case in ICT. The physical requirement then lends itself to the spatial nature of workers and the professional habits shared among them.

In addition to the mode of knowledge production, knowledge requirements in biotechnology- and ICT-based business are also conceptually different. Both biotechnology and ICT (or computer sciences in general) contain sub-disciplines, a combination of which needs to be designed for a product to materialise. However, sub-disciplines within biology are many and constantly increasing in number (Giacomelli and Covani, 2010), not to mention their sometimes ill-defined boundaries. In comparison, ICT allows more modularity (Fine, 1998), the division of labour is therefore more stable in ICT than in biotechnology. Combined with the physical requirements in knowledge production, the disintegration and spatial distribution of activities are relatively less problematic in ICT than in biotechnology.

Referring to how both types of knowledge are treated in the review, there is at least one further conceptual omission in addition to the internal diversity of an ideal type. So far, I have been silent regarding the integration of technologies into a commercial proposition. It has to be recognised that a product offering, especially that based primarily on analytical knowledge, requires a mixture of components (Jensen, Johnson, Lorenz and Lundvall, 2007) whose inherent properties and modes of production may vary. It also goes without saying that a commercially-viable combination should involve elements of synthetic, engineering-based knowledge as well. These components cohere into a whole in a number of ways (Henderson and Clark, 1990; Matusik and Hill, 1998). The knowledge required for the coordination of various knowledge-based elements has not been mentioned here although one may be able to conjecture that it plays a role in the pattern observed from biotechnology firms.

From the findings, biotechnology firms present a coherent picture, although it is the one which defies the explicit-global scenario. Documentation and publication are the essence of basic sciences, leading to the ubiquity of information. Common sense follows that a business based on such knowledge does not need as much proximity as

does, say, the race car industry (Pinch and Henry, 1999). Reporting on the horizontal dynamics of observation and imitation in this field is negligible. In fact, spatial proximity is thought to be impeded by the preciousness of intellectual property rights (McAdam and Marlow, 2008). Furthermore, the shared norms of scientists are more epistemic than geographical (Liebeskind *et al.*, 1996). Biotechnology as a collection of numerous sub-disciplines in molecular biology entails a very high degree of specialisation (Orsenigo and Pammolli, 2001). A research group, not to mention an individual researcher, can only specialise within a narrow field. The complication further arises when more technological disciplines come into play, such as medicine, chemistry, and computer sciences. Engineering also involves in the commercialisation phase. A single location cannot possibly satisfy all knowledge requirements even the mere technical ones.

Then why do we still observe the congregation of biotechnology firms around a basic research facility every now and again? Being close to a specific research centre may be less about obtaining any specific resource but more about socialising into a spatially-proximate epistemic community which collectively acts as a boundary spanner. Especially for the cases of scientist/entrepreneurs, socialisation is invariably more convenient with the existing group of familiar scientists than the distant experts. The latest developments constantly emerge in biotechnology and they tend to encompass a number of sub-fields, reflecting how “inter-disciplinary” is a buzzword in biology (Friedlander, 2007). Such news is circulated formally and informally among those working on relevant areas. However, a mere access to printed information is not always sufficient. In science, the “conceptions of similarity” is tacitly understood and cannot be simplistically reduced into information processing (Nightingale, 1998: 705). What scientists have technically mastered may matter less to a firm than how different but related fields are organised in their minds and how such perception further guides the firm’s knowledge of the relevant fields. The expanded horizon primes a firm for new opportunities, influences distant knowledge sourcing, and may help increase the absorptive capacity at both firm and group levels.

Setting aside the knowledge access as a given, it is the firm's attempt to map the terrain of relevant knowledge and configure their current and desired knowledge resources that matters. Putting the overall pursuit this way also leads to the possibility that a single spatial dimension, either distant or proximate, cannot possibly satisfy a firm's purpose. It is more likely that the necessary knowledge resources are far away, but neighbours may help give an idea on how to find and use them. I have not found a validation for or against this conjecture perhaps because the "knowledge of how to configure knowledge" is never consciously being sought such that it is more elusive to capture than the science itself.

### **6.2.2 Qualitative variations of a similar pattern**

For roughly the same category of spatial dimension, qualitative variations within which are to be expected. Careful attention can be directed at how the spatial characteristics itself is defined (e.g. "How far is far"?) and how similar end results can be traced back to different leading paths.

From the papers reviewed, different levels apply to the notion of a spatially proximate group of firms. In general, there are local, regional, and national levels. The national level is perhaps the least problematic to define, although some clusters can span across national borders (Porter, 1998). The local and regional levels are more difficult to distinguish, perhaps as a result of legal definitions of geography specific to a country being studied. Some studies define the boundary of a cluster around a city (Mackinnon *et al.*, 2004), some extend to a number of neighbouring towns (Pinch and Henry, 1999), and some regard a region as the boundary (Tödtling and Kaufmann, 2002). If a researcher reported no clustering activities in a region, could the result be any different at the town level? This is particularly problematic in drawing a conclusion from multi-country studies. Therefore, a resulting pattern simply stated as localised or non-localised gives an answer that invites a few more questions.

Some studies have suggested expressing the distances in physical units (i.e. in kilometres or miles) (McCann and Folta, 2008). While this alleviates the definitional

problem, it opens up to another. Is the same physical distance perceived as equally far by people from different industries or countries? In a homogeneous and spatially compact country, perhaps no place is perceived as far if it is still within the national perimeter. Two regions at the opposite ends of the country are arguably farther away from each other, physically and cognitively, in India than in the Netherlands. Whether the administrative boundary or the spatial distance should make the primary focus depends on a researcher's judgment. Interpretations may be necessary when comparing two findings that report, for example, a cluster in the *state* of California (Porter, 1998) and the *national-level* activities found in the Netherlands (Wever and Stam, 1999). Therefore, the sensitivity for the cultural, legal, and industrial aspects of a context is necessary to understand research findings.

In Chapter 5, there are two cases of localised clusters presented side-by-side, one regarding the Oulu South electronics cluster (Virkkala, 2007) and another on the British Motor Sport Valley (Pinch and Henry, 1999). Both depict an evident pattern of co-location which coincides with their engineering knowledge base, the importance of incremental product development, and the horizontal dynamics of observation and imitation. All of these characteristics agree with the theoretical geography of synthetic knowledge base. However, a question remains. Is the localisation an intended action aimed for benefit or merely "the way it has always been"?

Despite some similarities, these two clusters differ dramatically in the competitive contexts. This difference may have resulted in further differences in a) the conduct of clustered firms and b) the incentives and motivation to co-localise. In other words, these two cases demonstrate that co-location is an umbrella term that may not always be sufficiently informative. The Motor Sport Valley is subject to intense competition whose outcome is exceptionally objective (race title). The rapid, continuous improvement each firm needs gives a tremendous incentive to be inside the cluster which acts as a gigantic web of laboratories. Collective experiments carried out by atomised actors provide an indispensable feedback mechanism for innovation processes. This is the type of mechanism unattainable by a single large organisation or

a research institute. In contrast, the Oulu South firms also aggregate, but perhaps on the basis of the lack of incentives to venture outside rather than the existence of incentives to stay in.

Extending to the cases of Upper Austria (Tödtling and Kaufmann, 2002) and the research triangle in Germany (Sternberg, 1999) which also show a remarkable level of co-location, the qualitative difference from Pinch and Henry (1999) or Mackinnon *et al.* (2004) is still discernible. The difference now lies in the gravitational forces pulling the firms together, one is the institutional support in a given space and the other is the industrial importance of the locale. These two types of sustaining forces have both led to co-location though with very different locale-specific routines.

### **6.2.3 The possibility of reverse causality**

This issue should be of particular concern in quantitative research. There are certain concerns that render assigning a certain direction of causality problematic. The reverse or even iterative causality may have played a role in the general tendencies. These issues may be applicable specifically to two conditional factors—the market and the existence of local peers and to some extent, the institutional environment. They also restrict the applicability of the findings only to the cross-sectional picture of already existing firms.

The general tendencies suggest that:

1. Customers are the most important source of knowledge and their location reflects that of the knowledge sourcing (Section 5.2)
2. The lack of local peers drives firms to source knowledge extra-locally, whereas a more localised pattern can be observed upon the existence of similar local firms (Section 5.3)

Are these conditional dimensions always conditional, i.e. do they precede the choice of knowledge sourcing? While the reviewed literature seems to have suggested so, I would speculate the alternative possibilities. Markets and peers do not exist without a

firm's proposition, as what a firm does determines who buys its products and against whom it competes. By design, the review does not have a capacity to incorporate the effect of strategic choice. While the observed general tendencies allow us to think of markets and local peers as the influencing factors on knowledge sourcing, bringing in strategic choice may reverse such direction.

At the conception of a firm, decisions have to be made regarding which products or services it would offer. A part of the decision is inevitably based on, and constrained by, internal resources and capabilities of the firm and the opportunities available. There can be a number of different ways in arriving at the firm's set of propositions. One way is for a firm to visualise the perceived gaps between the capabilities it owns and those needed for a range of potential products. In terms of knowledge, the decision may be made upon the gap-bridging means available to the firm. In other words, it is the range of possible ways to gain access to knowledge that shapes a firm's offerings and as a consequence, the market in which it operates and the firms with which it competes.

We have settled here because our friends are here and because the cluster is here. You have access to everything and you need these resources nearby to be able to compete

(Interview quoted in Lechner and Dowling, 2003: 9)

Therefore, there is a possibility that the choice of knowledge sourcing influences a firm's market strategy at its outset or its diversification attempt. The causality can even be iterative as the firm reconfigures its internal capabilities and its product offerings over its time of service.

The concern of reverse and iterative causality restricts the applicability of the review findings. The findings, conceived of in this certain way, only apply to existing firms in a cross-sectional manner as the reverse causality may be the case at a firm's birth and the iterative causality may play a role over its progression. However, the congruence between the general tendencies and the cross-sectional pattern observed should hold

in ordinary cases. The main concern here is that a pattern on its own may not always lead to the “understanding” of why firms do what they do.

### 6.3 Understanding the geography of knowledge sourcing

Relatively few studies have provided convincing empirical evidence of the relative importance and/or superiority of local over non-local forms of cooperation in innovation.

(Doloreux and Mattson, 2008: 351)

Perhaps such evidence may not be attainable or even necessary. The preoccupation on what spatial proximity does perhaps stemmed from the rigid interpretations of industrial districts and the externalities. Ideally speaking, firms invariably wish to seek the best possible knowledge for themselves regardless of geography. Insisting on a strict adherence to spatial proximity would therefore be a self-defeating argument. Still, some geographical patterns emerged from how firms locate the knowledge they wish to acquire. This systematic review set out from the intention to understand what guides a firm’s decision to source knowledge in a particular way.

If the answer to this review question is to be made in once sentence, it should be that there is no universally ideal type of knowledge sourcing. The general tendencies give certain meanings to spatial proximity which, in turn, interacts with other types of proximity. Expecting the convenience of a unified model is theoretically problematic and practically not very helpful. The way I put across the answer is not meant in a nihilistic way. While the general tendencies discussed in this review are limited in their explanatory power towards a firm’s conscious action, the backdrop they provide helps anticipate the outcome. In interpreting the findings, it should be appreciated that each conditional dimension does not work in isolation even though it may seem feasible in a few cases. All of the dimensions should be taken into account simultaneously in *anticipating* the geographical pattern of knowledge sourcing.

Another task of *understanding* why firms do what they do adds multiple layers above and below the general tendencies as discussed in 6.2. These layers are what the clean

synthesis of factors cannot provide as they are highly dependent on the interplay between the context, parts of which are captured by the conditional dimensions, and the managerial choice which I could not design the conceptual categorisation to cover. Complexity now arises from a firm's attempt to balance preferences and constraints. While certain aspects of both can be common to most firms, the decisive factors that allow a firm to make a difference are likely to be grounded in its operating context, purpose, history, and routines. The contextual sensitivity can both expose the limitations and enhance the explanatory value of general tendencies. A case-specific set of relevant factors is required for the task. Therefore, while general tendencies can be found, I would still contend that understanding a firm's knowledge sourcing goes against mass generalisability.

## **6.4 Policy implications**

According to the policy relevance, I intend only to cover spatially defined networks which would be referred to as clusters for simplicity.

In a nutshell, the discussion (section 6.3) points to the lack of generalisability. The popularisation of clusters (Martin and Sunley, 2003) is especially perplexing given the constant warnings from economic geographers (McDonald, Huang, Tsagdis and Tüselmann, 2007; Morgan, 2004; Rabellotti and Schmitz, 1999). It is commonly accepted that a cluster follows an individual, distinct path (Dosi, 1997) which defies precise anticipation (Orsenigo and Pammolli, 2001). The usefulness of "best practice" is therefore limited in cluster policy (Gertler, 2001).

As the review does not take a system focus, another policy warning does not come directly from the review but instead cascades from the first implication. It follows that *ex ante* design of a cluster is invariably problematic if not downright impossible.

## **6.5 Further research opportunities**

This systematic review started gives rise to a number of research opportunities, some of which are discussed here.



### The firms and the institutional environment

The findings indicate that the institutional environment of a nation-state has some influence on how firms source knowledge, especially from the national/regional innovation systems (NIS/RIS) point of view. Despite such acknowledgement, we understand very little of how firms interact with the system or why they behave the way they do in relation to this factor. It seems that the two levels cannot converge as they are because they have been analysed by different theories due to different constructs of interest. NIS/RIS deals with the economics of the system, hence the limited capacity to account for heterogeneity of actors. If there is no place for managers in economics, where do firms stand in the institutional environment? How much do management theories allow for interactions with institutional actors whose economic rationale differs from profit-seeking firms? Is there an analytical means to facilitate the conversation between both levels? I should make clear that this is different from calling for an integrated theory. At least from the policy point of view, allowance for idiosyncrasies is perhaps desirable but impractical.

### Egocentric network of a firm

Another issue observed in the findings is that they only apply cross-sectionally to already existing firms (section 6.2.2). I think the utility of networking should also be understood as firms progress through various stages of life. At least in terms of resources, changes in the resource profile should entail different needs in networking. A network-level study may only capture this in multiple slices of cross-sections, as a complete heterogeneity can be very difficult to accommodate. Therefore, my interest is in how an individual firm develops its own network. It is particularly interesting to see how firms within the same network develop their own distinct set of relations.

To follow a firm's network building, the theoretical perspective I used to formulate the review question (section 2.3) may need to be refined or changed. The RBV lends itself more to analysing a stock of resource. This may also lead to the problem of multiple cross-sections instead of a more continuous picture.

## Scientific knowledge stock, relational asset, expanded horizon and architectural knowledge in biotechnology

This opportunity is related to the discussion of why biotechnology firms tend to congregate (section 5.1.2.1 and 6.2.1). It is interesting to examine in practice how a biotech firm's network leads to technology acquisition, relational capital, expanded perception, and architectural knowledge/innovation. The actual question would be how these constructs interact or reinforce one another. Much like the research in a firm's egocentric network, this type of research is likely to be longitudinal and focused on a single or very few focal firms. Again, the RBV may not be sufficient on its own through the course of this inquiry. It should be noted that this question may be more suitable for science-based rather than engineering-based firms.

### **6.6 Personal learning**

It has been interesting to see what kind of ramifications can be triggered by a fairly rudimentary question of "what people do", both in what I learn about myself and the phenomenon of interest.

I did not know what kind of answer I would get from the literature, or if I was going to get one. I found it quite easy to make peace with the sense of not knowing as I was scouring for the literature. The most difficult part of the process for me was the articulation. The paralysis caught me by surprise as soon as I knew the answer (the geography of knowledge sourcing and its conditional dimensions) and realised I had to actually write it down somewhere in an intelligible manner. I think it was how my mentality responded to stress and pressure. I also had three unsuccessful attempts trying to write the discussion part and by the time I got to the final theme I began to wonder why it took so long. Then I realised that my fourth attempt built on the struggle of the first three. I guess somehow nothing replaces time and failures but we just do not always have that kind of luxury.

I found that it took time to understand why I did not understand certain things. As I looked through the findings on nation-states, I started noticing how I could never fit a

firm into an NIS framework the way I wished to. Another instance was when I made a point that the review would only apply to existing firms in a cross-section manner. I began to realise why dynamic capabilities and the evolutionary theory mattered. I had nominally accepted their significance before but not until then had I really appreciated their value. This came across as quite a surprise because my review took off in a consciously atheoretical tone. I now see the value of “looking at the data” and thinking accordingly, not the other way around.

Another point I have learned about myself is that I am more comfortable at expanding rather than consolidating. Not only does this contribute to my self-awareness, it also tells me about the type of people I should work with.

## 7 Conclusion

This review provides an aggregate account of the empirical research regarding the spatial characteristics of knowledge sourcing by technology-based SMEs. It reveals four conditional dimensions which influence the overall geographical pattern of knowledge sourcing. However, these dimensions are far from being straightforward. The review argues that the utilisation of these factors rests on two notions—the acknowledgement of the limitations inherent in how the findings are formalised, and the sensitivity to case-specific context.

Case-specific context is indeed very challenging to visualise, given the current network-level orientation of the extant literature. It follows that the review has probably raised more questions than it has answered. I call for a better refined understanding on a) the relationship between private firms and the institutional environment, b) how an individual firm builds and develops own network, and c) how a firm's relational asset and different types of knowledge interact.

Diversity in how we inquire into the phenomenon of knowledge, technology-based firms and networks is necessary for better utilities on both business and policy sides. In conjunction with the network view, a firm-based view may enable us to better inform owners/manager as well as to escape from stylised policy exercise.

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## **APPENDIX**

### **Appendix A Summary of selected articles**

Information for each of the selected articles can be found in the following page.

**Figure\_Apx 1 Summary of selected texts**

No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
1	Britton, J. N. H. (2004), "High Technology Localization and Extra-Regional Networks", <i>Entrepreneurship and Regional Development</i> , Vol. 16, No. 5, p. 369-390.	No support for local inter-firm proposition as per cluster theories Market connection as the main determinant of knowledge sourcing pattern	N	2*	Quantitative	Questionnaire survey: 61 firms in Toronto	Canada	Canada	Electronics
2	Buenstorf, G. and Fornahl, D. (2009), "B2C—Bubble to Cluster: The Dot-Com Boom, Spin-Off Entrepreneurship, and Regional Agglomeration", <i>Journal of Evolutionary Economics</i> , Vol. 19, No. 3, p. 349-378.	Local collaboration and knowledge flow facilitated by shared background but different functions in the division of labour Public policy support not always a prerequisite for self-sustaining clusters	Y	3*	Qualitative	Interviews: 12 Intershop spin-off founders, managers of other local software firms, one academic computer scientist at a local university	Germany	Germany	ICT
3	Clifton, N., Keast, R., Pickernell, D. and Senior, M. (2010), "Network Structure, Knowledge Governance, and Firm Performance: Evidence from Innovation Networks and SMEs in the UK", <i>Growth and Change</i> , Vol. 41, No. 3, p. 337-373.	Complex and context-dependent nature of networks Support for cross-locality of networks and certain effects of spillovers from universities	Y	N/A	Quantitative	Questionnaire survey: 455 firms from each of the 12 standard UK regions	UK	UK	Unspecified
4	Cooke, P., Kaufmann, D., Levin, C. and Wilson, R. (2006), "The Biosciences Knowledge Value Chain and Comparative Incubation Models", <i>Journal of Technology Transfer</i> , Vol. 31, No. 1, p. 115-129.	Complexity of designing and providing incubation services (including business and scientific knowledge) to new biotechnology firms Spatial aggregation of biotech firms (note: necessarily the case as the incubators are the main phenomenon)	Y	N/A	Qualitative	Questionnaires and interviews: Incubatees and incubator managers from four European and one Israeli incubators Incubator managers from three North American incubators	UK	UK, France, Germany, Italy, Israel, US, Canada	Biotechnology

No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
5	Dankbaar, B. (1998), "Technology Management in Technology-Contingent SMEs", <i>International Journal of Technology Management</i> , Vol. 15, No. 1-2, p. 70-81.	Technology intensive and contingent firms differ in their pattern of knowledge sourcing, especially by means of customer interactions	Y	3*	Quantitative	Questionnaire survey: 302 firms	The Netherlands	Belgium, the Netherlands, Germany	Manufacturing
6	Davenport, S. (2005), "Exploring the Role of Proximity in SME Knowledge-Acquisition", <i>Research Policy</i> , Vol. 34, No. 5, p. 683-701.	The role of the existence of market and local peers in influencing a firm's market strategy and knowledge sourcing	N	4*	Qualitative	Interviews: Representatives from 15 firms	New Zealand	New Zealand	Electronics, food, industrial chemistry, industrial furniture, medical equipment, ICT
7	De Bernardy, M. (1999), "Reactive and Proactive Local Territory: Co-Operation and Community in Grenoble", <i>Regional Studies</i> , Vol. 33, No. 4, p. 343-352.	The importance of favourable institutional condition and local competences on collective, localised learning	Y	4*	Qualitative (historical analysis)	Not directly specified, but likely archival	France	France	Various
8	Doloreux, D. and Mattson, H. (2008), "To What Extent do Sectors "Socialize" Innovation Differently? Mapping Cooperative Linkages in Knowledge-Intensive Industries in the Ottawa Region", <i>Industry and Innovation</i> , Vol. 15, No. 4, p. 351-370.	Support for "local buzz and global pipelines" metaphor	N	2*	Quantitative	Questionnaire survey: 172 firms in Ottawa	Canada	Canada	Manufacturing, service
9	Fontes, M. (2005), "Distant Networking: The Knowledge Acquisition Strategies of 'Out-Cluster' Biotechnology Firms", <i>European Planning Studies</i> , Vol. 13, No. 6, p. 899-920.	How biotech firms may overcome the challenge of spatial distance by develop a mixture of alternative types of proximity, despite the continuing necessary of temporary co-location with key sources in knowledge-intensive regions	N	N/A	Qualitative	Interviews and secondary data: Four older firms Two younger firms	Portugal	Portugal	Biotechnology

No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
10	Fukugawa, N. (2006), "Determining Factors in Innovation of Small Firm Networks: A case of Cross Industry Groups in Japan", <i>Small Business Economics</i> , Vol. 27, No. 2-3, p. 181-193.	Policy-induced collaborations of local firms	Y	3*	Quantitative	Questionnaire survey: 1064 representatives of cross-industry groups	Japan	Japan	Manufacturing
11	Hendry, C. and Brown, J. (2006), "Organizational Networking in UK Biotechnology Clusters", <i>British Journal of Management</i> , Vol. 17, No. 1, p. 55-73.	That the co-localisation or the cluster itself is matters less to the networking pattern to the clustered firms than other industrial factors like science-technology base, research funding, business models, and competitor strategies in evolving markets	Y	3*	Quantitative	Combination of two previous empirical surveys (Hendry and Brown, 2006: 57): Brown and Hendry, 2001 Hendry and Brown, 2000	UK	UK	Biotechnology
12	Huggins, R. and Johnston, A. (2009), "Knowledge Networks in an Uncompetitive Region: SME Innovation and Growth", <i>Growth and Change</i> , Vol. 40, No. 2, p. 227-259.	The tendency of SMEs in uncompetitive regions to source knowledge extra-locally although larger SMEs tend to have a better balance of intra- and extra-regional knowledge networks.	Y	N/A	Quantitative	Questionnaire survey: 49 firms in Yorkshire and Humberside	UK	UK	Manufacturing, service
13	Jones, O. and Macpherson, A. (2006), "Inter-Organizational Learning and Strategic Renewal in SMEs: Extending the 41 Framework", <i>Long Range Planning</i> , Vol. 39, No. 2, p. 155-175.	The influence from external organisations in the distribution of knowledge and the adoption of knowledge	N	3*	Qualitative	Interviews, observations, internal documents: Three firms	UK	UK	Aerospace, water treatment, Office filing equipment, electronics

No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
14	Julien, P., Andriambeloson, E. and Ramangalahy, C. (2004), "Networks, Weak Signals and Technological Innovations Among SMEs in the Land-Based Transportation Equipment Sector", <i>Entrepreneurship and Regional Development</i> , Vol. 16, No. 4, p. 251-269.	How most manufacturing SMEs are more likely to source knowledge from business networks (customers, suppliers, subcontractors) but those few with connection to research and educational institutions are likely to be more innovative	Y	2*	Quantitative	Questionnaire survey: 146 land-based transportation equipment manufacturers in Quebec	Canada	Canada	Manufacturing
15	Kirkels, Y. and Duysters, G. (2010), "Brokerage in SME Networks", <i>Research Policy</i> , Vol. 39, No. 3, p. 375-385.	Brokerage as a way of sourcing knowledge and the possible role of public sector as brokers	Y	4*	Quantitative	Questionnaire survey: 93 SME employees and entrepreneurs	The Netherlands	The Netherlands	Design, medical technology, high-tech systems, automotive, nano- & Microsystems, ICT, new materials
16	Lechner, C. and Dowling, M. (2003), "Firm Networks: External Relationships as Sources for the Growth and Competitiveness of Entrepreneurial Firms", <i>Entrepreneurship &amp; Regional Development</i> , Vol. 15, p. 1-26.	Importance of co-location on network control and cluster quality on time economies Distinct relational mix (weak/strong ties) needed for each individual firm	N	2*	Qualitative	Interviews and questionnaires: 10 firms in Munich	France	Germany	ICT
17	Liebeskind, J. P., Oliver, A. L., Zucker, L. and Brewer, M. (1996), "Social Networks, Learning, and Flexibility: Sourcing Scientific Knowledge in New Biotechnology Firms", <i>Organization Science</i> , Vol. 7, No. 4, p. 428-443.	Social networks among scientists as a precursor for learning and flexibility not achievable by an individual organisation	N	4*	Qualitative	Interview, archives, media, patent data: Two firms	US	US	Biotechnology



No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
18	Lindelöf, P. and Löfsten, H. (2004), "Proximity as a Resource Base for Competitive Advantage: University-Industry Links for Technology Transfer", <i>Journal of Technology Transfer</i> , Vol. 29, No. 3-4, p. 311-326.	Higher inclination of science park firms to collaborate with local universities compared to off-park firms	Y	N/A	Quantitative	Questionnaire survey (matched samples): 134 science park firms 139 off-park firms	Sweden	Sweden	ICT, consulting, electronics, pharmaceutical, mechanics, industrial chemistry
19	Lissoni, F. (2001), "Knowledge Codification and the Geography of Innovation: The Case of Brescia Mechanical Cluster", <i>Research Policy</i> , Vol. 30, p. 1479-1500.	Knowledge flows via key engineers instead of freely within the cluster.	N	4*	Mixed	Interviews followed by questionnaire survey: Engineers from five firms in Brescia and a few users	Italy	Italy	Machinery
20	Lorentzen, A. (2007), "The Geography of Knowledge Sourcing - A Case Study of Polish Manufacturing Enterprises", <i>European Planning Studies</i> , Vol. 15, No. 4, p. 467-486.	Predominantly global nature of knowledge sourcing with customers as the most important knowledge sources No support for local "buzz" or clustering	Y	N/A	Qualitative	Interviews: Management representatives from 23 firms in Krakow and Wroclaw	Denmark	Poland	Manufacturing
21	Mackinnon, D., Chapman, K. and Cumbers, A. (2004), "Networking, Trust and Embeddedness Amongst SMEs in the Aberdeen Oil Complex", <i>Entrepreneurship and Regional Development</i> , Vol. 16, No. 2, p. 87-106.	Aberdeen as the crucial location for forms of industry-specific information and expertise even with the presence of wider knowledge resources outside.	Y	2*	Qualitative	Interviews: 34 SME managers in Aberdeen oil complex	UK	UK	Oil and gas

No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
22	Mason, G., Beltramo, J. and Paul, J. (2004), "External Knowledge Sourcing in Different National Settings: A Comparison of Electronics Establishments in Britain and France", <i>Research Policy</i> , Vol. 33, No. 1, p. 53-72.	The influence of hiring practice, influenced by labour mobility and educational system, on knowledge sourcing of the firms and knowledge opportunities available to them	N	4*	Qualitative	Interviews and direct observations: 26 British firms (southern England, Scotland) 22 French firms (Brittany, Ile de France, Rhône-Alpes)	UK	France, UK	Electronics
23	McAdam, M. and Marlow, S. (2008), "A Preliminary Investigation into Networking Activities within the University Incubator", <i>International Journal of Entrepreneurial Behaviour &amp; Research</i> , Vol. 14, No. 4, p. 219-241.	Role of university incubator in developing networks, especially those of social and business types	Y	1*	Qualitative	Three-year longitudinal data collection (interviews, observations, informal discussions): Six startups in a UK incubator (four in biotechnology, two in ICT)	UK	UK	ICT, biotechnology
24	Mohannak, K. (2007), "Innovation Networks and Capability Building in the Australian High-Technology SMEs", <i>European Journal of Innovation Management</i> , Vol. 10, No. 2, p. 236-251.	Different natures of network configuration and knowledge activities in biotechnology and ICT clusters	Y	1*	Qualitative	Questionnaire survey: 16 biotechnology firms in Sydney 48 ICT firms in Melbourne Interviews: 10 representatives of ICT firms	Australia	Australia	ICT, Biotechnology

No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
25	Mytelka, L. K. (2004), "Clustering, Long Distance Partnerships and the SME: A Study of the French Biotechnology Sector", <i>International Journal of Technology Management</i> , Vol. 27, No. 8, p. 791-808.	Practices of firms in biotechnology clusters	Y	3	Quantitative	Questionnaire survey: 25 SMEs in six clusters of five French regions	The Netherlands	France	Biotechnology
26	Pinch, S. and Henry, N. (1999), "Paul Krugman's Geographical Economics, Industrial Clustering and the British Motor Sport Industry", <i>Regional Studies</i> , Vol. 33, No. 9, p. 815-827.	Knowledge dissemination via untraded interdependencies and labour mobility	Y	4*	Qualitative	Interviews: Over 50 senior managers, designers and engineers in the leading teams and component suppliers	UK	UK	Motor sport
27	Sternberg, R. (1999), "Innovative Linkages and Proximity: Empirical Results from Recent Surveys of Small and Medium Sized Firms in German Regions", <i>Regional Studies</i> , Vol. 33, No. 6, p. 529-540.	Supporting argument for the strong and increasing intraregional linkages	Y	4*	Quantitative	Questionnaire survey: 1,806 manufacturing firms in Baden, Saxony, and the research triangle in Lower Saxon	Germany	Germany	Manufacturing
28	Tödtling, F. and Kaufmann, A. (2002), "SMEs in Regional Innovation Systems and The Role of Innovation Support--The Case of Upper Austria", <i>Journal of Technology Transfer</i> , Vol. 27, No. 1, p. 15-26.	Firms receiving innovation support being more innovative and less confined within the region	Y	N/A	Quantitative	Questionnaire survey: 140 firms from the Upper Austria region	Austria	Austria	Unspecified
29	Tolstoy, D. (2010), "Knowledge Combination in Networks: Evidence from the International Venturing of Four Small Biotech Firms", <i>International Entrepreneurship and Management Journal</i> , Vol. 6, No. 2, p. 183-202.	Different practice of knowledge sourcing according to product/market strategies	Y	N/A	Qualitative	Interviews: 12 interviews with nine respondents from four firms	Sweden	Sweden	Biotechnology

No.	Reference	Contribution to findings/discussion	From search string? (Y/N)	Journal Rating	Analytical orientation	Main data and sample	First author's country of affiliation	Field Country	Sector
30	Trippl, M., Tödtling, F. and Lengauer, L. (2009), "Knowledge Sourcing Beyond Buzz and Pipelines: Evidence from the Vienna Software Sector", <i>Economic Geography</i> , Vol. 85, No. 4, p. 443-462.	Significant informal and formal knowledge linkages in all spatial levels Correspondence between radical innovation and diverse knowledge sources and transfer mechanisms	N	N/A	Quantitative	Questionnaire survey: 29 firms in Vienna	Austria	Austria	ICT
31	Van Geenhuizen, M. (2007), "Modelling Dynamics of Knowledge Networks and Local Connectedness: A Case Study of Urban High-Tech Companies in the Netherlands", <i>Annals of Regional Science</i> , Vol. 41, p. 813-833.	Coexistence of local/regional/global knowledge networks Presence of regionally active service as a partial basis for the relative importance of local/regional knowledge interaction	Y	2*	Quantitative	Interviews, semi-structured questionnaires, reports: 21 firms	The Netherlands	The Netherlands	ICT, electronics, biotechnology
32	Virkkala, S. (2007), "Innovation and Networking in Peripheral Areas - a Case Study of Emergence and Change in Rural Manufacturing", <i>European Planning Studies</i> , Vol. 15, No. 4, p. 511-529.	Local SMEs being locally/regionally bound than large firms Shared background as a sustaining force for localised activities	Y	N/A	Qualitative	Interviews: 10 representatives of supporting agents 12 representatives of firms	Finland	Finland	Electronics
33	Werr, A., Blomberg, J. and Löwstedt, J. (2009), "Gaining External Knowledge - Boundaries in Managers' Knowledge Relations", <i>Journal of Knowledge Management</i> , Vol. 13, No. 6, p. 448-463.	Types and importance of relationships with knowledge sources Boundary dimensions enabling/inhibiting knowledge acquisition by an individual manager	Y	N/A	Qualitative	Interviews: 31 managers and professionals in seven SMEs	Sweden	Sweden	Manufacturing, ICT
34	Zhu, D. and Tann, J. (2005), "A Regional Innovation System in a Small-Sized Region: A Clustering Model in Zhongguancun Science Park", <i>Technology Analysis &amp; Strategic Management</i> , Vol. 17, No. 3, p. 375-390.	Policy-influenced configuration and spatiality	Y	2*	Qualitative	Not directly specified, but mainly secondary data, both of qualitative and quantitative nature	UK	China	Unspecified